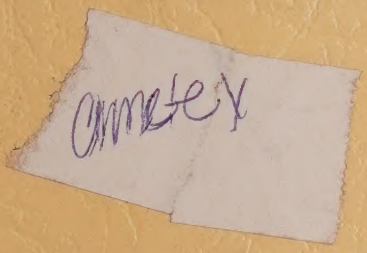
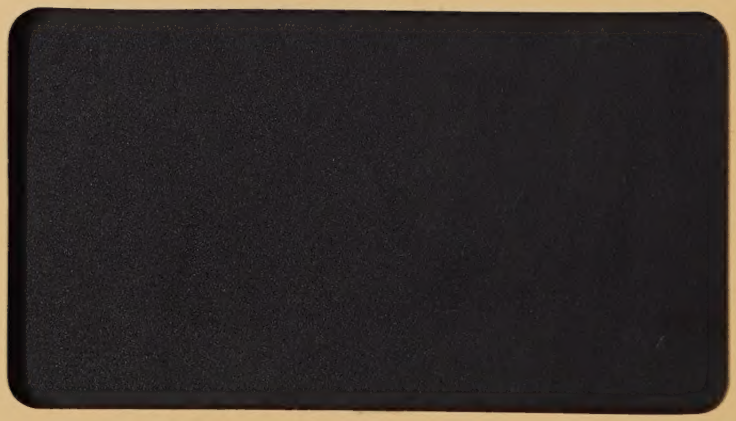
General Radio

INSTRUCTION MANUAL





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WARRANTY

We warrant that this product is free from defects in material and workmanship and, properly used, will perform in full accordance with applicable specifications. If, within a period of ten years after original shipment, it is found, after examination by us or our authorized representative, not to meet this standard, it will be repaired or, at our option, replaced as follows:

- No charge for parts, labor or transportation during the first three months after original shipment;
- No charge for parts or labor during the fourth through the twelfth month after original shipment for a product returned to a GR service facility;
- No charge for parts during the second year after original shipment for a product returned to a GR service facility;
- During the third through the tenth year after original shipment, and as long thereafter as parts are available, we will maintain our repair capability and it will be available at our then prevailing schedule of charges for a product returned to a GR service facility.

This warranty shall not apply to any product or part thereof which has been subject to accident, negligence, alteration, abuse or misuse; nor to any parts or components that have given normal service. This warranty is expressly in lieu of and excludes all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose, and all other obligations or liabilities on our part, including liability for consequential damages resulting from product failure or other causes. No person, firm or corporation is authorized to assume for us any other liability in connection with the sale of any product.

Type 1782 Analog Limit Comparator

C

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Concord, Massachusetts, U.S.A. 01742
Form 1782-0100-C
February, 1974
ID-0100

Condensed Operating Instructions

Referenced paragraph contains unabridged information.

OPERATION WITH 1654 IMPEDANCE COMPARATOR

(3.1) Set the rear-panel LIMIT 1 and LIMIT 2 INPUT switches to A and the LIMIT 3 and LIMIT 4 switches to B.

1654	**A** Phase-angle difference Radians		**B** Magnitude difference %	
1782	LIMIT 1 LOW	LIMIT 2 HIGH	LIMIT 3 LOW	LIMIT 4 HIGH

Set the front-panel LIMIT 1 and LIMIT 3 switches to LOW and the LIMIT 2 and LIMIT 4 switches to HIGH.

Set the LIMIT dials for the proper low and high limits. Note that the LIMIT-dial markings correspond directly with the 1654 meter markings.

For example: The 1654 is set for a full-scale indication of 0.01 radians phase-angle difference and a 3% magnitude difference and it is desired to select components for between −0.005 and +0.007 radians and ±2%. Set the 1782 LIMIT dials as follows:

LIMIT 1	LIMIT 2	LIMIT 3	LIMIT 4
5 (inner scale)	7 (inner scale)	2 (outer scale)	2 (outer scale)

Specifications

INPUT

Analog Voltage: ±10 V full scale

Resistance (of each comparator): 66 kΩ, approx.

OUTPUT

Analog Voltage: Identical to input.

Decision Outputs: Visual or relay contacts.
Visual: NO-GO lamp for each limit; GO lamp indicates measurement is within all limits.
Relay Contacts (optional): 5 SPDT contacts, 115 V rms, 0.1 A rms, max.

Accuracy: ±2% of full scale.

Limit Controls: Four independent limits; can be set for + (high) or − (low) with switch adjoining each control. Dual controls: inner scale calibrated 0 to 100 (each division corresponds to 100 mV), outer scale calibrated 0 to 30 (316 mV per division).

Test Speed: Approx 10 tests per second, max.

Power Required: 105 to 125 or 210 to 250 V, 50 to 60 Hz, 20 W.

Accessories Supplied: 24-contact connector with relay models only, input-signal cable, power cord.

Mounting: Convertible bench cabinet.

Dimensions (width x height x depth): Bench, 17 x 3⅞ x 9⅞ in. (435 x 99 x 250 mm); rack, 19 x 3½ x 8⅝ in. (485 x 89 x 220 mm).

Weight: Net, 9 lb (4 kg); shipping, 15 lb. (7 kg).

Catalog Number	Description
	1782 Analog Limit Comparator
1782-9700	Bench Model, without relays
1782-9701	Rack Model, without relays
1782-9702	Bench Model, with relays
1782-9703	Rack Model, with relays

Introduction—Section 1

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1.1 PURPOSE

The 1782 increases the speed at which the 1654 Impedance Comparator and 1662 Resistance Limit Bridge will operate in both manual and automatic sorting applications.

1.2 DESCRIPTION

It compares the analog-voltage output of the bridge against high and low limits set on the front panel and displays GO or NO GO lights for manual sorting. Optional relay-equipped models will operate external automatic-sorting devices. Up to four components per second can be measured with instrument combinations.

Four controls on the front panel permit the limits to be set to 1% resolution; each control can act as either a high limit or a low limit as selected by a rear-panel switch.

1.3 ACCESSORIES SUPPLIED.

Table 1-1
ACCESSORIES SUPPLIED

Qty	Description	GR Part Number
1	Instruction Manual	1782-0100
1	Power cord, 3-wire, 7-foot, IEC Safety Standard	4200-9625
2	Spare lamps, Type 330, 14-V, 80-mA; fits all lamps	5600-0309
1	Signal cable, 3-foot with Type 126 male and female connectors; for connection to Type 1654 Impedance Comparator or 1662 Resistance Limit Bridge or to another 1782.	4205-1100
1	Connector, Type 57, 24-contact male connector; for connection of external equipment to RELAY CONTACTS connector (supplied only with comparators with relay option)	4220-3024
1	Rack adaptor set (supplied only with rack models)	0480-9702

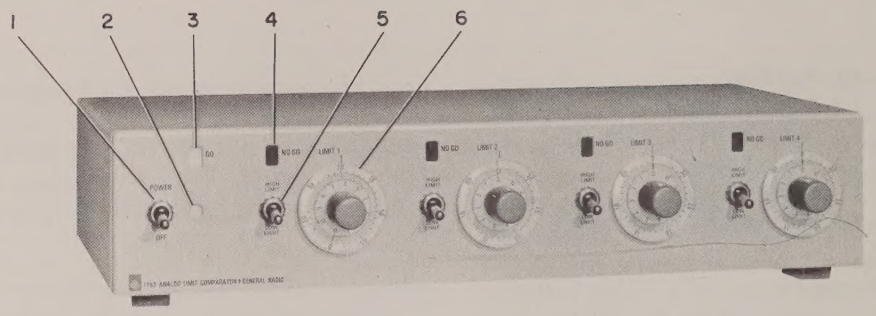

Figure 1-1. Front-panel controls and indicators.

1.4 FRONT PANEL.

Table 1-2
FRONT PANEL CONTROLS AND INDICATORS

Fig. 1-1 Ref.	Name	Function
1	POWER	Two-position toggle switch. Applies line voltage to the instrument.
2	Pilot lamp	Incandescent lamp with white filter. Lights when power is applied (POWER switch is on).
3	GO lamp	Incandescent lamp with white filter. Lights when comparison result is GO (within all preset tolerances).
4	NO GO lamps	Incandescent lamps with red filters (one for each of the four limits). Light when comparison result is NO GO (out of tolerance).
5	LIMIT switches	Two-position toggle switches (one for each of the four limits). Determines whether LIMIT-dial setting is an upper limit (HIGH LIMIT position) or a lower limit (LOW LIMIT position).
6	LIMIT dials	Potentiometer controls (one for each of the four limits). Set upper or lower limits, depending on setting of LIMIT switches, for comparison.

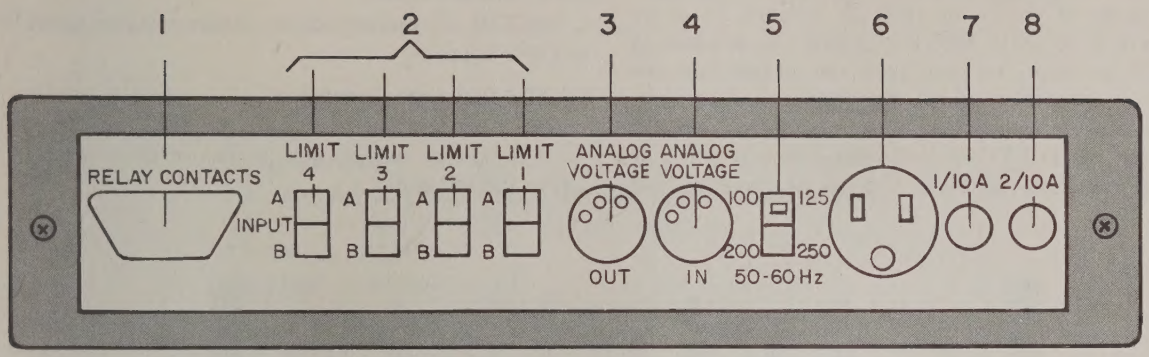

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Figure 1-2. Rear-panel controls and connectors.

1.5 REAR PANEL.

Table 1-3
REAR PANEL CONTROLS AND CONNECTORS

Fig. 1-2 Ref.	Name	Function
1	RELAY CONTACTS	24-pin female connector (relay models 1782-9702 and 1782-9703 only). Provides control signals to external sorting equipment.
2	INPUT switches	Two-position slide switches (one for each of the four limits) determine signal source for comparison (A input is phase-angle difference from 1654 Impedance Comparator and B input is magnitude difference). B input should be used with 1662 Resistance Limit Bridge.
3	ANALOG VOLTAGE OUT	7-pin female connector. Connected in parallel with ANALOG VOLTAGE IN connector and provides input signals to another 1782 Analog Limit Comparator.
4	ANALOG VOLTAGE IN	7-pin female connector. For connection of input signal or signals. Connected in parallel with ANALOG VOLTAGE OUT connector.
5	Line switch	Two-position screwdriver-operated slide switch. Selects line-voltage range: 100 to 125 V or 200 to 250 V, 50 to 60 Hz, 20 W.
6	Power connector	Three-pin male connector. For connection to power line. Accepts 3-wire power cord supplied (Belden SPH-386 or equivalent).
7	230-V fuse	Fuse, 0.1 A Slo-Blo for 200- to 250-V operation.
8	115-V fuse	Fuse, 0.2 A Slo-Blo for 100 to 125-V operation.

1.6 EQUIPMENT AVAILABLE.

1.6.1 Impedance Comparisons.

To sort resistances of 2 Ω to 20 MΩ including Q, capacitances of 50 pF to 1000 μF including D, or inductances of 20 μH to 1000 H including 1/Q, at speeds up to 4000 per hour, the comparator can be used with the 1654 Impedance Comparator. The 1654 measures the difference between two external impedances at frequencies of 100 Hz, 1, 10, or 100 kHz and at test voltages of 0.3, 1, or 3 V and provides the results in terms of magnitude and phase-angle difference accurate to 3% of full scale (see paragraph 2.8 for connections).

1.6.2 Other Equipment.

The 1782 will operate with any device whose output is 0 to ±10 V full scale.

1.6.3 DC Resistance Comparison.

The 1782 can be used with the 1662 Resistance Limit Bridge for multiple limit sorting of resistors from 2 Ω to 100 MΩ at dc.

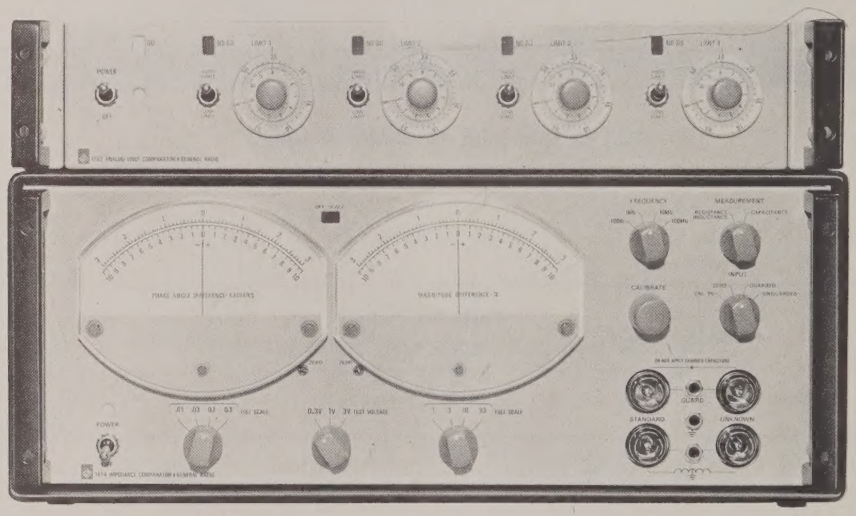

Figure 1-3. The 1654 Impedance Comparator with its companion accessory, Type 1782 Analog Limit Comparator.

Installation–Section 2

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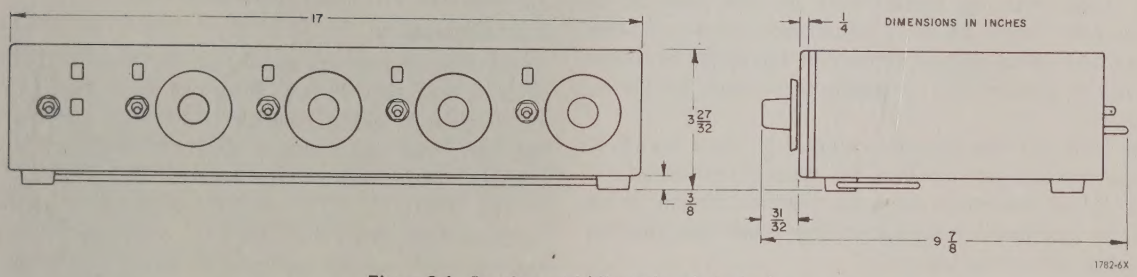

Figure 2-1. Bench model (dimensions in inches).

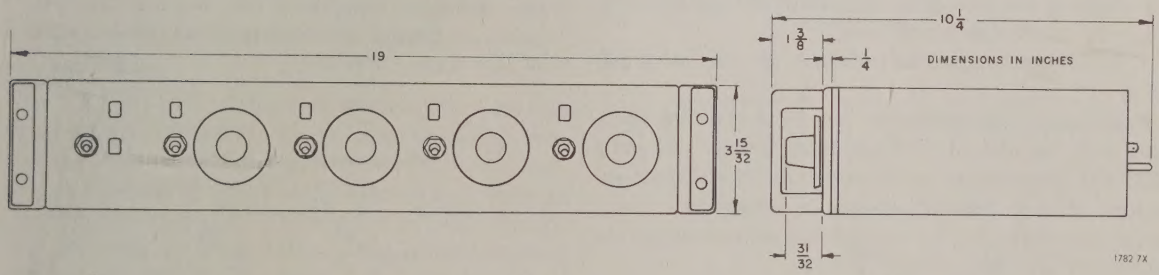

Figure 2-2. Rack model (dimensions in inches).

2.1 POWER.

Power requirements are 100 to 125 V or 200 to 250 V, 50 to 60 Hz, 20 W. A line switch, S502 on the rear panel, selects the line-voltage range. For 115-V operation, F501 (0.2 A, Slo-Blo) protects the instrument and for 230-V operation, F502 (0.1 A Slo-Blo) protects the instrument.

Connection to the power line is made by means of a 3-wire, 7-foot power cord, supplied, that attaches to the power connector, PL501 on the rear panel. The long center pin is connected directly to the frame of the instrument (frame ground, ⏚, designated GND).

2.2 MOUNTING

2.2.1 Basic Data.

The 1782 Analog Limit Comparator is a tilt-base convertible-bench instrument, has a panel height of 3.5 in., a depth of 8 in., and dissipates 20 W, maximum.

2.2.2 Cabinet Options.

Bench model. For bench use. Includes a tiltable bench-cabinet assembly. To convert to a rack model, proceed as follows:

a. Order a 0480-9702 rack adaptor set.

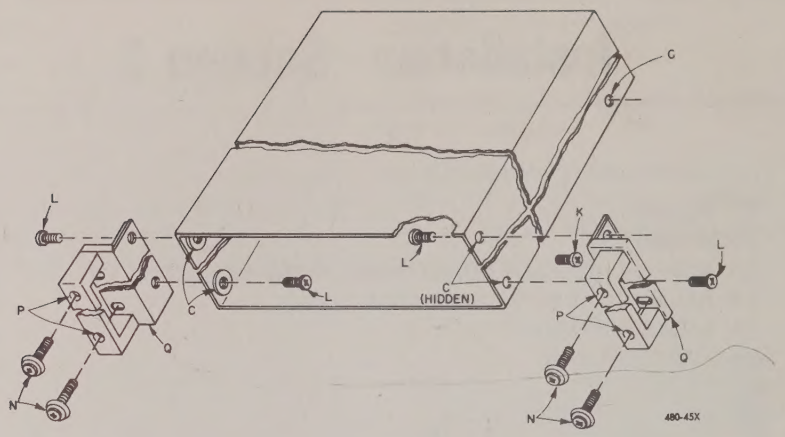

Figure 2-3. Rack-mount assembly.

b. Disconnect any cabling from the rear panel of the instrument, loosen the two Phillips-head screws on the rear panel (the screws are held in place on the cabinet by rubber O-rings to prevent loss), and slide the cabinet off the instrument.

c. Push out the four knockouts (c); use a punch or similar tool and push out from the inside of the cabinet.

d. If the instrument is to be mounted directly above another instrument, push out the four rubber feet attached to the bottom of the cabinet.

e. Attach the rack adaptors with the four screws(L) as shown.

f. Replace the cabinet on the instrument and secure in place with the Phillips head screws.

g. Install the instrument in the rack; see next paragrpah 2.2.3.

Rack model. For installation in an EIA standard 19-in. relay rack. Includes a tiltable bench-cabinet assembly and a 0480-9702 rack-adaptor set. To install the rack-adaptor set, perform steps b through f above. To convert to a bench model, simply remove the rack adaptor set and replace the rubber feet (with bail stand) if removed.

2.2.3 Rackmounting (rack models).

To install a rack-model instrument in an EIA standard 19-in. relay rack, insert the instrument in the rack and secure it to the rack with the four front panel screws (N); no rear support is necessary.

2.3 ANALOG VOLTAGE CONNECTORS.

2.3.1 Connections.

The input signals are applied to the ANALOG VOLTAGE IN connector, PL901 on the rear panel. This is a type 126 7-contact male connector (Amphenol part number 126-197), that mates with a type 126 7-contact female connector (Amphenol part number 126-198).

The ANALOG VOLTAGE IN connector is paralleled with the ANALOG VOLTAGE OUT connector, SO903 on the rear panel, so that the input signals can also be used by such auxiliary equipment as a voltmeter, recorder, or another comparator. SO903 is a type 126 7-contact female connector (Amphenol part number 126-198), that mates with a type 126 7-contact male connector (Amphenol part number 126-197).

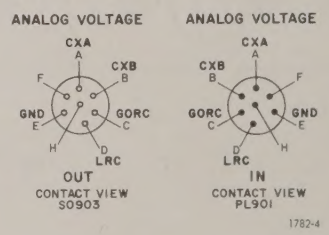

Figure 2-4. Pin diagrams of SO903 and SO901.

2.3.2 Signals.

1654 signal 1654 SO909 pin	POV A	MOV B	GA2 C	GA1 D	GND E	blank F	blank G
1782 PL901 and SO903 pin **1782 signal**	A **CXA**	B **CXB**	C **GORC**	D **LRC**	E **GND**	F blank	G blank

CXA, CXB input signals (diagram C). These are the input signals for comparison and must be dc; negative for low-limit comparisons, positive for high-limit comparisons, and within 10 V of ground. The input resistance of each of the four comparison circuits is ≈ 66 kΩ, so that if both a low and a high limit of a signal is required, the input signal is into ≈ 33 kΩ.

LRC no-go inhibit (diagram C). A 0-level (closure to ground) signal applied to the LRC input inhibits all four NO-GO lamps and, in models with the relay option, inhibits all four NO-GO relays. When used with the 1654 Impedance Comparator, LRC is at the 0-level when no unknown is connected (rear panel START switch set to SELF) or before the START button on the test fixture is pushed (rear panel START switch set to EXT). Thus, before a measurement, all NO-GO lamps and relays are de-energized. After a measurement they are allowed to be energized in the normal manner.

GORC go inhibit (diagram C). A 0-level (closure to ground) signal applied to the GORC input inhibits the GO lamp and, in models with the relay option, inhibits the GO relay. When used with the 1654 Impedance Comparator, LRC is at the 0-level when no unknown is connected (rear panel START switch set to SELF) or before the START button the the test fixture is pushed (rear panel START switch set to EXT). Thus, before a measurement, the GO lamp and relay are deenergized. About 200 ms after a measurement they are allowed to operate in the normal manner.

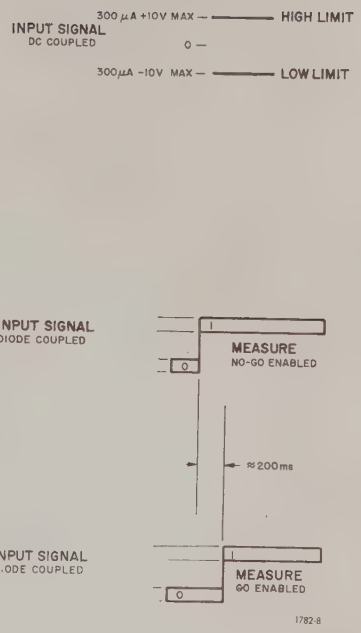

Figure 2-5. Input signal characteristics.

2.4 RELAY CONTACT CONNECTOR, SO902.

2.4.1 Connections.

The RELAY CONTACTS connector, SO902 on the rear panel, provides connections to the contacts of five spdt relays in comparators with the relay-board option. These relays can be used to control such external equipment as component-sorting devices. SO902 is a type 57 24-contact female connector (Amphenol part number 57-40240), that mates with a type 57 24-contact male connector (Amphenol part number 57-30240).

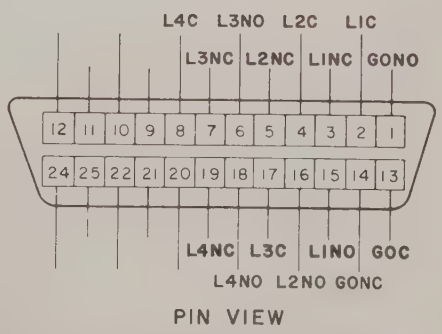

Figure 2-6. SO902 pin diagram. (See paragraph 6.1 for signal index definitions.)

2.4.2 Signals.

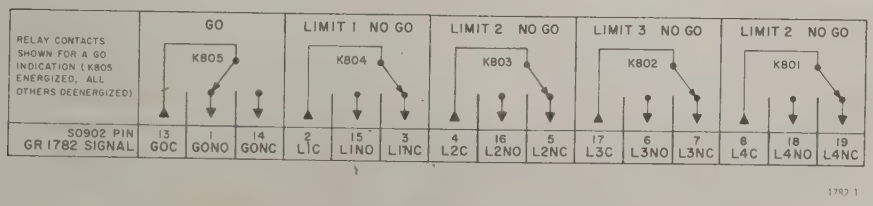

Figure 2-7. Operation of sorting relays .

Relay contacts (diagram M). The contact ratings are 115 V rms, 0.1 A rms with the contact protection values of 0.0047 μF and 120 Ω supplied. With changes in these values, the contacts can be protected from highly inductive loads or can be protected up to 100 VA (2A max, 500 V max); write factory for specific details on individual requirements. Typical connections to sorting equipment are shown in Figure 2-8.

2.5 CABLE ASSEMBLY.

2.5.1 4205-1100 Signal Cable.

The 4205-1100 signal cable is a 3-foot 7-conductor cable primarily intended to connect the 1782 to the 1654 Impedance Comparator.

Connections:

Female pin	Conductor color	Male pin
A	WH-OR-BR	A
B	WH-OR-BU	B
C	WH-GY-BK	C
D	WH-OR-GN	D
E	BK	E
F	WH-OR-RD	F
H	WH-OR-GY	H

2.6 LIMIT SORTING.

Up to 32 comparators can be driven from a single 1654 Impedance Comparator. (Each output from the 1654 will drive up to 64 comparator circuits. Since there are two outputs, A and B, from the 1654 and four comparator circuits in each 1782, a single 1654 will drive (64 x 2)/4 = 32 1782's.

2.6.1 Connections to Sorting Equipment.

Connections to sorting equipment (1782's with relay option only) are made to the RELAY CONTACTS connector, SO902 on the rear panel (more fully described in paragraph 2.4). The 4220-3024 connector, supplied, with appropriate cabling can be used.

Multiple-group sorting. A single comparator can sort components into five groups: both radians and % in tolerance, low radians, high radians, low %, and high %.

Multiple-limit sorting (single quantity). Two comparators can sort components into five categories according to either radians or % or both. For example: ±5%, ±10%, ±20%, ±30%, and reject.

Other. The number of comparators, the limit settings, and the connections from the relay contacts to the external sorting equipment can be varied to suit most all applications.

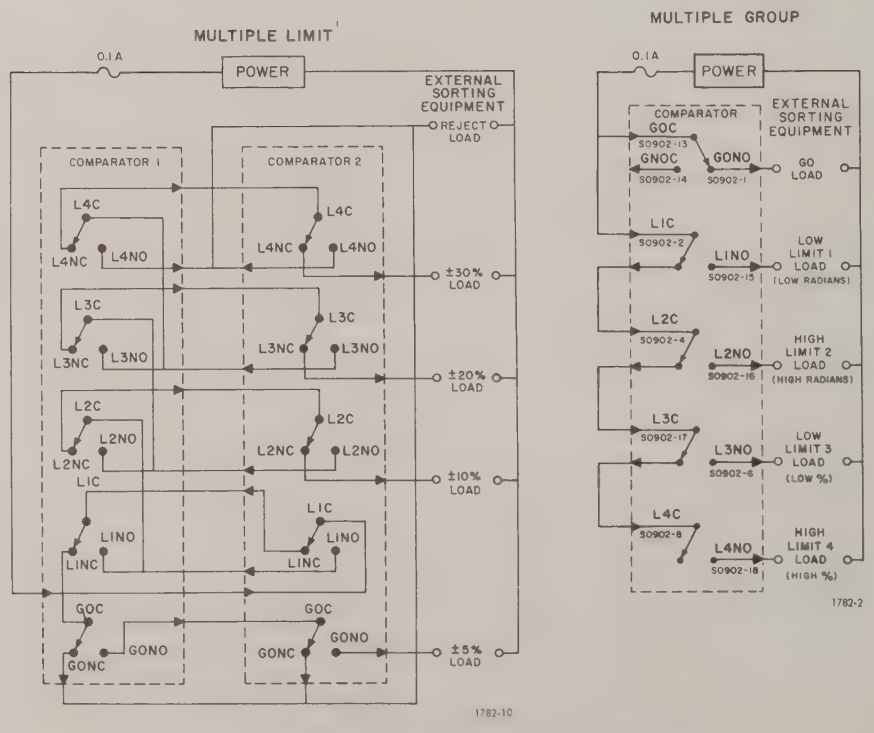

Figure 2-8. Interface with external sorting equipment.

Operation–Section 3

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3.2 OPERATION WITH 1662 9

3.1 OPERATION WITH 1654.

3.1.1 Setup.

Connect the 4205-1100 signal cable, supplied, from the ANALOG LIMIT COMPARATOR connector, S0909 on the rear panel of the 1654, to the ANALOG VOLTAGE IN connector, PL901 on the rear panel of the 1782. Set the LIMIT 1 and LIMIT 2 switches to A and set the LIMIT 3 and LIMIT 4 INPUT switches to B. Connect both instruments to a source of power (be sure the line switches on the rear panel are set for the proper line voltage) and turn the POWER switches on. Equipment interconnections are more fully described in paragraphs 2.3 through 2.6.

3.1.2 Controls

Set the LIMIT 1 and LIMIT 3 switches to LOW, set the LIMIT 2 and LIMIT 4 switches to HIGH, and set the LIMIT dials for the proper high and low limits. Note that the LIMIT-dial markings correspond directly with the 1654 meter markings.

1654	**A** Phase-angle difference Radians		**B** Magnitude difference %	
1782	LIMIT 1 LOW	LIMIT 2 HIGH	LIMIT 3 LOW	LIMIT 4 HIGH

Example. The 1654 is set for a full-scale indication of 0.01 radians phase-angle difference and 3% impedance difference and it is desired to select components for between −0.005 and + 0.007 radians and ±2%. Set the 1782 LIMIT dials as follows:

LIMIT 1	LIMIT 2	LIMIT 3	LIMIT 4
5 (inner scale)	7 (inner scale)	2 (outer scale)	2 (outer scale)

When unknown is disconnected from the 1654, the 1782 GO and NO-GO lamps are deenergized and the contacts of the relays, if installed, are in their normally-closed position.

3.2 OPERATION WITH 1662.

3.2.1 Setup.

Connect the 4205-1100 signal cable, supplied, from the ANALOG LIMIT COMPARATOR connector, S0903 on the rear panel of the 1662, to the ANALOG VOLTAGE IN connector, PL901 on the rear panel of the 1782. Set the LIMIT 1, LIMIT 2, LIMIT 3 and LIMIT 4 INPUT switches to B. Connect both instruments to a source of power (be sure the line switches on the rear panel are set for the proper line voltage) and turn the POWER switches on. Equipment interconnections are more fully described in paragraphs 2.3 through 2.6.

3.2.2 Controls.

Set the LIMIT 1 and LIMIT 3 switches to LOW, set the LIMIT 2 and LIMIT 4 switches to HIGH, and set the LIMIT dials for the proper high and low limits. Note that the LIMIT-dial markings correspond directly with the 1662 meter markings.

1662	**B** Resistance difference %			
1782	LIMIT 1 LOW	LIMIT 2 HIGH	LIMIT 3 LOW	LIMIT 4 HIGH

Example. The 1662 is set for a full-scale indication of 10% resistance difference and it is desired to select components for between ±5% and ±10%. Set the 1782 LIMIT dials as follows.

LIMIT 1	LIMIT 2	LIMIT 3	LIMIT 4
5 (inner scale)	5 (inner scale)	10 (inner scale)	10 (inner scale)

When unknown is disconnected from the 1662, the 1782 GO and NO-GO lamps are deenergized and the contacts of the relays, if installed, are in their normally-closed position.

Theory–Section 4

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4.1 COMPARATOR BOARD C.

Diagram C. The comparator board contains four identical comparison circuits. Each circuit accepts one of two input signals, compares it to a low limit or a high limit, and provides a visual indication of the comparison result (GO if in-tolerance, NO GO if out-of-tolerance).

4.1.1 Input Signal.

CXA and CXB inputs. The input signals, CXA and CXB, from the external device are applied to the ANALOG VOLTAGE IN connector, PL901, on the rear panel; (this plug is wired in parallel with the ANALOG VOLTAGE out connector, SO903 on the rear panel, so that the input signals can be used with another 1782). These must be dc signals, either positive or negative, and within 10 V of ground.

If the external device is a 1654 Impedance Comparator: The CXA input signal is proportional to the phase-angle difference between the unknown and standard and is positive if the phase angle of the unknown is greater than that of the standard or is negative if it is less. The CXB input signal is proportional to the magnitude difference between the unknown and standard and is positive if the impedance of the unknown is greater than that of the standard or is negative if it is less. A full-scale indication on both meters on the 1654 produces a 10-V output for all settings of the TEST VOLTAGE or FULL SCALE range switches.

CD input. The CXA and CXB signals are connected to the INPUT switches, S905 through S908 on the rear panel, which select one of the two input signals for comparison and apply it as CD (CD1, 2, 3, or 4) to the input of the comparison circuit.

4.1.2 Low Limit.

Limit voltage. For comparisons to a low limit, the LIMIT switch, S901, 2, 3, or 4 on the front panel, is set to LOW LIMIT which applies +15 V (CJ) to voltage dividers that contain the LIMIT dials (R901, 2, 3, or 4 on the front panel). The LIMIT dial, via its wiper voltage (CK), sets the voltage at the base of the first transistor (Q101, 7, 13, or 19) which is then compared with the input voltage CXA or CXB. Adjustment R105, 23, 41, or 59 on the comparator board, sets the corresponding input transistor for symmetrical voltage-level switching. CR101, 4, 7, and 10 keep the input transistors on for low-limit comparisons and off for high-limit comparisons when the LIMIT dial is 0 and the input voltages are zero. CR102-103, 105-106, 108-109, and 111-112 protect the first transistor from over-voltage inputs.

Go (quiescent), is described in terms of the limit-1 comparison circuit. When the CD1 input signal is zero or positive, Q101 base is always sufficiently positive to turn on Q101 regardless of the setting of the LIMIT dial. When Q101 is on, it turns off Q103, which turns off Q104 and sets Q104 collector to a negative voltage. One output from Q104 collector is returned through R109 to Q102 base which turns off Q102 and causes its emitter to go more negative. Since Q101 and Q102 share a common-emitter resistor, the more negative voltage at Q102 emitter causes Q101 to conduct more heavily. Thus, Q101, Q103, Q104, and Q102 form a regenerative loop so that,when Q101 begins to conduct, the loop forces it to conduct to saturation, much the same as if Q101 and Q102 were connected as a flip-flop.

No go, described in terms of the limit-3 comparison circuit. When the CD3 input signal is negative, the comparison circuit remains in its go state only so long as the input amplitude is less than the limit voltage. When the amplitude exceeds the limit voltage, Q113 base goes negative, which turns off Q113 and sets CL3 to a positive voltage. CL3 passes through the LIMIT switch, emerges as L3RC, turns on Q118, and sets L3RA near ground, which energizes the NO GO lamp.

4.1.3 High Limit.

Limit voltage. For comparisons to a high limit, the LIMIT switch is set to HIGH LIMIT which applies −15 V (CJ) to voltage dividers that contain the LIMIT dials.

Go (quiescent), described in terms of the limit-4 comparison circuit. When the CD4 input signal is zero or negative, Q119 base is always sufficiently negative to turn off Q119 regardless of the setting of the LIMIT dial. When Q119 is off, it turns on Q121 which turns on Q122 and sets Q122 collector to a positive voltage. One output from Q122 collector is returned through R163 to Q120 base, which turns on Q120 and causes its emitter to go more positive. Since Q119 and Q120 share a common emitter resistor, the more positive voltage at Q120 emitter causes Q119 to conduct less heavily. Thus, Q119, Q120, Q121, and Q122 form a regenerative loop so that when Q119 begins to turn off, the loop forces it to cut off, much the same as if Q119 and Q120 were connected as a flip-flop.

No go, described in terms of the limit-2 comparison circuit. When the CD2 input signal is positive, the comparison circuit remains in its go state only so long as the input amplitude is less than the limit voltage. When the amplitude exceeds the limit voltage, Q107 base goes positive which turns on Q107 and sets CH2 to a positive voltage. CH2 passes through the LIMIT switch, emerges as L2RC, turns on Q112, and sets L2RA near ground, which energizes the NO GO lamp.

4.1.4 Go Indication.

Go and-gate. The outputs, L1R through L4R, from each no-go lamp driver are applied to a four-input positive and-gate. When all four inputs are positive (go level), diodes CR114, 116, 118, and 120, are back-biased, which allows Q125 base to go positive. With a positive base voltage, Q125 turns on and sets GORA near ground, which energizes the GO lamp.

Go inhibit. A 0-level (closure to ground) signal applied to either GORC input sets Q125 base near ground and deenergizes the GO lamp. When used with the 1654 Impedance Comparator, a 0-level input signifies the 1654 is not making a measurement and its data is therefore invalid.

No-go inhibit. A 0-level (closure to ground) signal applied to either LRC input sets Q106, 112, 118, and 124 bases to ground and deenergizes all NO-GO lamps. When used with the 1654 Impedance Comparator, a 0-level input signifies the 1654 is not making a measurement and its data is therefore invalid.

4.2 RELAY BOARD M.

Diagram M. The relay board (optional) contains five relays that are energized by the no-go and go signals from the comparator board. These relays are used to control external equipment such as an automatic sorting device

4.2.1 Go.

When all no-go signals are in their go state, the go signal, GOR, is in the go state (ground) which provides a gound return for K805 and K805 energizes. K805 is an spdt relay with all three contacts brought out to the RELAY CONTACTS connector, SO902 on the rear panel, so that an external voltage can be applied and controlled and then used to drive external equipment. The 120 Ω−.0047 μF RC network protects the contacts from burnout from signals up to 115 V rms, 0.1 A rms.

4.2.2 No Go.

When any no-go signal, L1R through L4R, is in the no-go state (ground), it provides a ground return for the associated relay and the relay energizes. All four relays are spdt relays and all three contacts of each relay are brought out to the RELAY CONTACTS connector.

4.3 POWER SUPPLY V.

Diagram V. The power supply provides two regulated voltages and two unregulated voltages for use by other circuits in the instrument.

4.3.1 −15 Volts.

V−15 regulated negative 15 volts. The line voltage is stepped down to ≈21 V rms by T501, rectified by bridge network CR505 through CR508, and applied as ≈20 V dc through current-sensing resistor R512 to the series pass transistor, Q505. The regulated −15 V (V−15) emerges at the collector of the series pass transistor. This voltage is also fed back to a voltage divider, R520, R519, and R518, whose output drives an error amplifier, Q508, which compares this input to ground. The resultant error signal is amplified by Q506 and is used to control the conduction of the series pass transistor, to maintain a constant −15 V output over a broad range of load- and line-voltage variations.

For example, if the −15 V output tries to go more negative, Q508 base goes more negative, causing Q508 to conduct more heavily. Its collector then goes less negative which causes Q506 to also conduct more heavily. Its collector goes more negative, which finally cause the series pass transistor, Q505, to conduct less and bring the −15 V output less negative (back to its proper value).

Q507 provides constant current to Q505 base, Zener diode CR514 provides a reference voltage for Q508 emitter, and CR512 the current available from the series pass transistor to prevent damage from overloads. CR512 functions as follows: As current through the series pass transistor increases, the voltage at CR512 anode becomes less negative until a point is reached where CR512 conducts. When it conducts, it provides additional forward-bias cur-

rent for Q506 base, Q506 conducts more heavily, and its collector becomes less negative until it reaches a point where it turns off the series pass transistor, Q505, before excess current burns it out. The supply is thus short proof.

V–15 V unregulated negative 15 volts. The unregulated voltage from the bridge network is applied to a dropping resistor, R524, emerges as the unregulated voltage, V-15 V, and is used only to energize the pilot lamp, P501.

4.3.2 +15 Volts.

V +15 regulated positive 15 volts. This supply operates the same as the –15 V supply except that its reference is –15 V instead of ground.

V-15 V unregulated positive 15 volts. This is obtained in the same manner as the unregulated –15 V. It is used to energize the GO and NO-GO lamps (diagram C) and the relays (diagram M).

4.4 THEORY SUMMARY

The 1782 (Figure 4-1) incorporates front-panel lamps to indicate GO or NO GO conditions. Each NO GO lamp indicates a single test limit, established as a preset voltage E_2. The input voltage E, derived from measurement channels of the bridge is compared with E_2, as shown in Figure 4-2. Unbalance voltage E_O, if it exists, is amplified by an operational amplifier with sufficient positive feed-back to cause the amplifier to switch off or on. Its output triggers the NO GO lamp drivers; if the comparison is out of established tolerance, the NO GO lamps will light. Within-tolerance conditions for all limits will trigger the GO lamp. Optional relay-equipped models operate external automatic sorting devices.

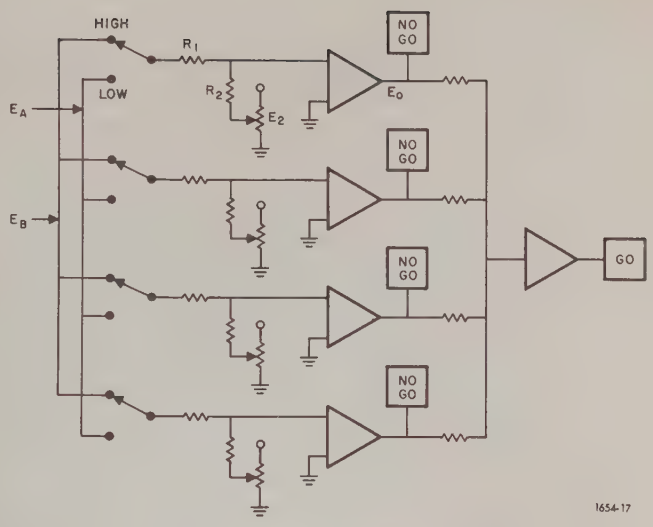

Figure 4-1. Simplified schematic diagram of 1782 Analog Limit Comparator.

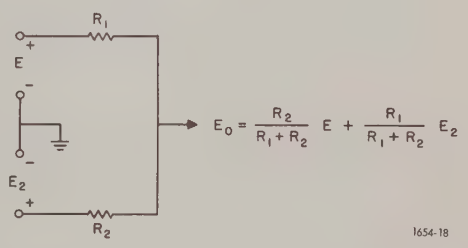

Figure 4-2. Comparison of input signal (E) with preset voltage (E_2) in 1782.

Service and Maintenance—Section 5

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5.2 REPAIR NOTES 14
5.3 CALIBRATION PROCEDURE 15

CAUTION

Turn power off before removing or replacing etched boards. Do not apply excessive heat to etched boards.

5.1 SERVICE.

The warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear page), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please contact our Service Department or nearest District Office, requesting a "Returned Material Tag." Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 REPAIR NOTES.

5.2.1 Knob Replacement.

To remove a knob, hold the dial firmly in place, grasp the knob securely and pull out—hard. The knob should pull off the dial and bushing assembly attached to the shaft. If, by some chance, the assembly also pulls off, insert a tap (of the same size as the hole in the bushing, 1/8, 1/4, or 3/8 in.) a few threads into the hole and pull the dial and bushing assembly out of the knob. Reinstall the assembly on the shaft and tighten the set screws.

To replace a knob, place it over the bushing and push—hard. This instrument includes four 5520-5220 knobs, one for each of the LIMIT dials (the part number is for the knob and its spring retainer only, and does not include the dial).

5.2.2 Etched Boards.

Replacement. For minimum down-time, a defective board can be replaced immediately thus keeping the instrument on-line while the defective unit is being repaired. Defective boards may be repaired in your facility or sent to the nearest General Radio Repair Center (see rear of book) for repair or replacement. This instrument contains the etched boards listed in Table 5-1.

Table 5-1

Etched Board	Type	Socket	GR Part Number	Notes
C Comparator	wired-in	———	1782-2701	Adjustment recommended, see paragraph 5.3.3.
M Relay	plug-in	SO901	1781-4785	Installed only in instruments with relay option.
V Power Supply	wired-in	———	1782-2751	Adjustment recommended, see paragraph 5.3.2.

Repair. Excessive heat can ruin an etched board by stripping off (delaminating) the etched wiring. To remove a transistor or integrated circuit, unsolder each pin with a 20 to 30-W temperature controlled soldering iron and use a desoldering tool (such as a Soldapullt®, Edsyn Inc., Box 868, Arleta, Calif.) to remove as much solder as possible. Then use a screwdriver or similar tool to gently push each pin away from the side of the hole and separate it from any remaining solder. After all pins have been freed, the component can be lifted from the board, easily and without application of excessive heat.

5.3 CALIBRATION PROCEDURE and Minimum Performance Standards

Additional information is contained in paragraph 6.1, Signal Index.

5.3.1 Preliminary.

Introduction. This procedure can be used for calibration or for verification of minimum performance standards. In either case, the steps must be performed in the order given and must pass before proceeding to the next step (unless noted otherwise) because each one serves as the foundation for the next. Defective boards may be repaired in your facility or sent to the nearest General Radio Repair Center (see rear of book) for repair or replacement.

Calibration. The 1782 Analog Limit Comparator incorporates the high reliability inherent in conservatively designed solid-state circuitry and routine calibrations are unnecessary.

Minimum Performance Standards. For incoming inspection or for other situations in which it is desired simply to verify the comparator's primary specifications and not to adjust, correct, or otherwise optimize the circuits, or check such secondary characteristics as power supply voltages, only the asterisked (*) steps need be performed (Table 5-3).

Equipment required. The specifications given are those necessary for the performance of the calibration procedure or minimum performance standard and are not necessarily those of the suggested equipment.

5.3.2 Power Supply. (Table 5-3)

This step checks the supply voltages from the power supply (diagram V).

Setup. Disconnect any cables connected to the rear of the comparator, loosen the Phillips-head screw on each side of the rear of the cabinet, and remove the cabinet from the comparator. Connect the comparator to the autotrans-

Table 5-2
TEST EQUIPMENT

Equipment	Characteristics		Suggested (GR equipment unless noted otherwise)
Autotransformer	Output: Meter:	100 to 125 V ac, 20 W ±3% accuracy	W5MT3VM, W5MT3A, W5MT3W, or W5MT3AW Metered Variac® Autotransformer.
Voltmeter	Range: Accuracy: Resolution:	0 to 16 V dc 0.2% of reading 1 mV	1820 Digital Voltmeter
Oscilloscope	Bandwidth: Sensitivity:	100 kHz, min 5 mV/div with 1X probe 5 V/div with 10 X probe	Tektronix Type 502, 503, or 504 Oscilloscope.
Dc source	Output: Ripple:	0 to 11 V dc < 1 mV, pk-pk	1346 Audio-Frequency Microvolter®
Ohmmeter	Range: Accuracy:	0 to 1 Ω ±20%	1806 Electronic Voltmeter or 1820 Digital Voltmeter.
Pulse generator	PRF: Duration: Amplitude:	100 Hz ±20% 5 ms ±20% 100 mV to 20 V pk-pk	1340 Pulse Generator

former, set the autotransformer for 115-V output, and set the comparator controls as follows:

LIMIT switches	HIGH
LIMIT dials	cw
POWER	OFF
INPUT switches (rear panel)	A
Line switch (rear panel)	100-125

5.3.3 Comparator Offset. **(Table 5-3)**

This step checks the offset voltage for each of the four comparator circuits (diagram C).

Control Settings (from previous step)	LIMIT switches	HIGH
	LIMIT dials	cw
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. Connect dc source and voltmeter to input A of ANALOG IN connector (PL901 pin A,) and ground input B (PL901 pin E).

5.3.4 Dial Adjustment. **(Table 5-3)**

This step calibrates the LIMIT dials for each of the four comparator circuits (diagram C).

Control settings (from previous step)	LIMIT switches	HIGH
	LIMIT dials	cw
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. Same as for previous step, paragraph 5.3.3.

5.3.5 Dial Accuracy.*

This step checks the accuracy of the LIMIT dials for each of the four comparator circuits and checks the GO circuitry (diagram C).

Control settings (from previous step)	LIMIT switches	HIGH
	LIMIT dials	5
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. (For MPS procedure only; calibration-procedure setup is same as for previous step, paragraph 5.3.4). Connect dc source and voltmeter to INPUT A of ANALOG IN connector (PL901 pin A) and ground input B (PL901 pin E).

Accuracy. Check the accuracy of each LIMIT dial as follows (before each check, reset comparator by momentarily setting INPUT switch to B then setting it back to A):

HIGH	1	+0.8 to +1.2 V
HIGH	3	+2.8 to +3.2 V
HIGH	5	+4.8 to +5.2 V
HIGH	8	+7.8 to +8.2 V
HIGH	10	+9.8 to +10.2 V
LOW	10	−9.8 to −10.2 V
LOW	8	−7.8 to −8.2 V
LOW	5	−4.8 to −5.2 V
LOW	3	−2.8 to −3.2 V
LOW	1	−0.8 to −1.2 V

Go lamp. Set all LIMIT switches to LOW and all LIMIT dials to 1, and set dc source to −0.1 V. Go lamp must be on.

5.3.6 Relay Board.*

This step checks the operation of the relay board in comparators with that option, 1782-9702 and 1782-9703 (diagram M).

Control settings (from previous step)	LIMIT switches	LOW
	LIMIT dials	1
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. Same as for previous step, paragraph 5.3.5.

5.3.7 Comparator Hysteresis. **(Table 5-3)**

This step checks the hysteresis voltage of each of the four comparator circuits (diagram C).

Control settings (from previous step)	LIMIT switches	LOW
	LIMIT dials	10
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. Same as for previous step, paragraph 5.3.6.

5.3.8 Comparator Switching. **(Table 5-3)**

This step checks the comparator switching characteristics (diagram C).

Control settings (from previous step)	LIMIT switches	HIGH
	LIMIT dials	5
	POWER	on
	INPUT switches	A
	Line switch	100-125

Setup. Connect pulse generator to input A of ANALOG IN connector (PL901 pin A, WH-OR-BN-BK) and set generator for 100-Hz, 5-ms, negative pulses.

Table 5-3
CALIBRATION CHART

Procedure	Indication
Power Supply.	
Turn POWER on	Pilot lamp must light
Adjustment. Connect voltmeter between AT137 (+15 V) and AT139 (−15 V).	Voltage must be 29.985 to 30.015 V (30 V ±.05%); if not adjust R519.
Regulation. Vary line voltage from 100 to 125 V.†	Voltage must not change more than .015 V (±.05%).
+15 volts. Set line voltage to 115 V and connect voltmeter between AT137 (+15 V) and AT138 (ground).	Voltage must be +14.955 to +15.045 V (+15 V ±.3%).
Connect oscilloscope to AT137 (+15 V) and vary line voltage from 100 to 125 V.	Combined ripple and noise must be < 5 mV, pk-pk.
−15 volts. Set line voltage to 115 V and connect voltmeter between AT139 (−15 V) and AT138 (ground).	Voltage must be −14.955 to −15.045V (−15 V ±.3%).
Connect oscilloscope to AT139 (−15 V) and vary line voltage from 100 to 125 V.	Combined ripple and noise must be < 5 mV, pk-pk.
Set line voltage to 115 V and disconnect voltmeter and oscilloscope.	
Comparator Offset.	
Limit 1. Set LIMIT 1 input switch to A, LIMIT switch to HIGH, and LIMIT dial fully ccw. Set dc source to +100 mV ghen gradually increase voltage until LIMIT 1 NO GO lamp lights.	Note positive voltage at which NO GO lamp lights (≈47 mV).
Set LIMIT switch to LOW, momentarily set INPUT switch to B (to reset comparator), then set it to A. Set dc source to −100 mV then gradually increase voltage until NO GO lamp lights.	Voltage must be within 2 mV of positive voltage above. If it isn't, adjust R105.
R105 affects both the positive and negative voltages at which the comparator triggers. Before checking either point, reset the comparator (ground the input by momentarily setting the INPUT switch to B).	
Limits 2, 3, and 4. Check offset of each comparator by setting its LIMIT dial fully ccw and all others fully cw and proceeding as for limit 1.	Positive and negative voltages must be within 2 mV. If they aren't, adjust R123 (limit 2), R147 (limit +), or R159 (limit 4).
Dial Adjustment.	
Limit 1. Set LIMIT 1 INPUT switch to A, LIMIT switch to HIGH, and LIMIT dial to 5. Gradually increase dc-source positive voltage until NO GO lamp lights. Set d-c source to + 10 V.	Voltage must be +4.8 to +5.2 V (+5V ±2% of full scale). If it isn't, remove LIMIT-dial knob (hold dial and pull out on knob—hard). Reset comparator by momentarily setting INPUT switch to B then setting it back to A. Set dc source to +5 V, loosen LIMIT-dial-bushing setscrew and position dial on shaft so that it indicates exactly 5 for NO GO indication, and replace knob (place over bushing and push).
Limits 2, 3, and 4. Check adjustment of each LIMIT dial as given for limit 1.	Voltages must be +4.8 to +5.2 V. If they aren't, position dial on shaft as directed for limit 1.

†For 230-V line inputs, set line switch to 200-250 and set autotransformer to 230 V or vary from 200 to 250 V.

Table 5-3 (Cont)
CALIBRATION CHART

Procedure		Indication
Relay Board.		
Go indication. Set all LIMIT switches to LOW and all LIMIT dials to 1, and set dc source to −0.1 V. Continuity must be as shown in table for GO indication.	GO Indication Continuity (0 Ω) between pins:	NO-GO Indication Continuity (0 Ω) between pins:
NO-go indication. Set dc source to −2 V. Continuity must be as shown in table for NO-GO indication.	2 and 3 4 and 5 8 and 19 13 and 1 17 and 7	2 and 3 4 and 5 8 and 19 13 and 1 17 and 7
Comparator Hysteresis.		
Limit 1. Set LIMIT 1 INPUT switch to A, LIMIT switch to HIGH, and LIMIT dial to 5. Gradually increase dc-source positive voltage until NO GO lamp lights.		Note voltage.
Gradually decrease voltage until NO GO lamp extinguishes		Note voltage. Difference between first and second voltage (hysteresis) must be 50 mV or less.
Limits 2, 3, and 4. Check hysteresis of each comparator as given for limit 1 above.		Hysteresis must be 50 mV or less.
Disconnect dc source and voltmeter.		
Comparator Switching.		
Set 1340 controls: SOURCE – HIGH PULSE AMPLITUDE – PULSE OFFSET –	Adjust for scope display.	
Limit 1. Connect oscilloscope to TP101. Increase pulse amplitude to ≈10 V pk-pk until waveform appears on oscilloscope.		Transitions must be clean and free of jitter and overshoot (pk-pk amplitude will be ≈20 V).
Limits 2, 3, and 4. Check switching characteristics of each comparator circuit as given for limit 1; connect oscilloscope to TP102 for limit 2, TP103 for limit 3, and TP104 for limit 4.		Transitions must be clean and free of jitter and overshoot (pk-pk amplitude will be ≈20 V).
Disconnect pulse generator and oscilloscope. Replace cabinet.		

Parts Lists and Diagrams – Section 6

6.1 SIGNAL INDEX 20,21

6.1 SIGNAL INDEX

Signal	Description *Connections (external access in parenthesis)	*Characteristics	Diagram (source in parenthesis)	Theory (source in parenthesis)
CD1	Limit 1 input, AT102, S905-3	DC, ±0 to 10 V	(C)	(4.1.1), (4.1.3)
CD2	Limit 2 input, AT113, S906-3	DC, ±0 to 10 V	(C)	(4.1.1), (4.1.3)
CD3	Limit 3 input, AT122, S907-3	DC, ±0 to 10 V	(C)	(4.1.1), (4.1.3)
CD4	Limit 4 input, AT130, S908-3	DC, ±0 to 10 V	(C)	(4.1.1), (4.1.3)
CH1	Limit 1 high output, AT106, S901-1	DC, no-go state:	(C)	(4.1.3)
CH2	Limit 2 high output, AT118, S902-1	DC, no-go state:	(C)	(4.1.3)
CH3	Limit 3 high output, AT125, S903-1	DC, no-go state:	(C)	(4.1.3)
CH4	Limit 4 high output, AT133, S904-1	DC, no-go state:	(C)	(4.1.3)
CJ1	Limit 1 reference, AT104, R901-CW, S901-6	DC, ±15 V	(C)	(4.1.2), (4.1.3)
CJ2	Limit 2 reference, AT114, R902-CW, S902-6	DC, ±15 V	(C)	(4.1.2), (4.1.3)
CJ3	Limit 3 reference, AT123, R903-CW, S903-6	DC, ±15 V	(C)	(4.1.2), (4.1.3)
CJ4	Limit 4 reference, AT131, R904-CW, S904-6	DC, ±15 V	(C)	(4.1.2), (4.1.3)
CK1	Limit 1 dial output, AT101, R901-W	DC,	(C)	(4.1.2), (4.1.3)
CK2	Limit 2 dial output, AT112, R902-W	DC,	(C)	(4.1.2), (4.1.3)
CK3	Limit 3 dial output, AT121, R903-W	DC,	(C)	(4.1.2), (4.1.3)
CK4	Limit 4 dial output, AT129, R904-W	DC,	(C)	(4.1.2), (4.1.3)
CL1	Limit 1 low output, AT105, S901-5	DC, no-go state:	(C)	(4.1.2)
CL2	Limit 2 low output, AT115, S902-5	DC, no-go state:	(C)	(4.1.2)
CL3	Limit 3 low output, AT124, S903-5	DC, no-go state:	(C)	(4.1.2)
CL4	Limit 4 low output, AT132, S904-5	DC, no-go state:	(C)	(4.1.2)
CXA	A external input, (PL901-A), SO905 thru S908-1, (SO903-A)	DC, ±0 to 10 V	C	(4.1.1)
CXB	B external input, (PL901-B), S905 thru S908-5, (SO903-B)	DC, ±0 to 10 V	C	(4.1.1)
GOC	Go relay common, SO901-19, (SO902-13)	———	M	(4.2.1)
GONC	Go relay normally closed, SO901-15, (SO902-14)	———	M	(4.2.1)
GONO	Go relay normally open, SO901-16, (SO902-1)	———	M	(4.2.1)
GOR	Go relay drive, AT110, SO901-20	DC, go state:	(C), M	(4.1.4), 4.2.1
GORA	Go lamp drive, AT109, P901	DC, go state:	(C)	(4.1.4)
GORC	Go complement, AT110, (PL901-C), (SO903-C)	DC, go state:	(C)	(4.1.4)
GND	Chassis ground, AT902, (PL901-E), (SO903-E)	———	C, M, (V)	(4.1.5)
LRC	No go, AT111, (PL901-D), (SO903-D)	DC, no-go state:		
L1C	Limit 1 relay common, SO901-18, (SO902-2)	———	M	(4.2.2)
L1NC	Limit 1 relay normally closed, SO901-11, (SO902-3)	———	M	(4.2.2)
L1NO	Limit 1 relay normally open, SO901-14, (SO902-15)	———	M	(4.2.2)
L1R	Limit 1 relay drive, AT107, SO901-17	DC, no-go state:	(C), M	(4.1.2), 4.1.4, 4.2.2
L1RA	Limit 1 no-go lamp drive, AT108, P902	DC, no-go state:	(C)	(4.1.2), (4.1.3)
L1RC	Limit 1 no-go complement, AT103	DC, no-go state:	(C)	(4.1.2), (4.1.3), 4.1.5
L2C	Limit 2 relay common, SO901-13, (SO902-4)	———	M	(4.2.2)
L2NC	Limit 2 relay normally closed, SO901-9, (SO902-5)	———	M	(4.2.2)
L2NO	Limit 2 relay normally open, SO901-10, (SO902-16)	———	M	(4.2.2)
L2R	Limit 2 relay drive, AT119, SO901-12	DC, no-go state:	(C), M	(4.1.2), 4.1.4, 4.2.2
L2RA	Limit 2 no-go lamp drive, AT116, P903	DC, no-go state:	(C)	(4.1.2), (4.1.3)
L2RC	Limit 2 no-go complement, AT117	DC, no-go state:	(C)	(4.1.2), (4.1.3), 4.1.5

L3C	Limit 3 relay common, SO901-8, (SO902-17)	———	M	(4.2.2)
L3NC	Limit 3 relay normally closed, SO901-5, (SO902-7)	———	M	(4.2.2)
L3NO	Limit 3 relay normally open, SO901-6, (SO902-6)	———	M	(4.2.2)
L3R	Limit 3 relay drive, AT126, SO901-7	DC, no-go state:	(C), M	(4.1.2), 4.1.4, 4.2.2
L3RA	Limit 3 no-go lamp drive, AT128, P904	DC, no-go state:	(C)	(4.1.2), (4.1.3), 4.1.5
L3RC	Limit 3 no-go complement, AT127	DC, no-go state:	(C)	(4.1.2), (4.1.3), 4.1.5
L4C	Limit 4 relay common, SO901-3, (SO902-8)	———	M	(4.2.2)
L4NC	Limit 4 relay normally closed, SO901-1, (SO902-19)	———	M	(4.2.2)
L4NO	Limit 4 relay normally open, SO901-4, (SO902-18)	———	M	(4.2.2)
L4R	Limit 4 relay drive, AT134, SO901-2	DC, no-go state:	(C), M	(4.1.2), 4.1.4, 4.2.2
L4RA	Limit 4 no-go lamp drive, AT136, P905	DC, no-go state:	(C)	(4.1.2), (4.1.3)
L4RC	Limit 4 no-go complement, AT135	DC, no-go state:	(C)	(4.1.2), (4.1.3), 4.1.5
V+15	Regulated +15 V, AT137, AT501	DC, +15 V with mV pk-pk noise	C, (V)	(4.3.1)
V+15T	Rectified +15 V, AT507, CR502-CR504	DC, with mV pk-pk noise	(V)	(4.3.1)
V+15U	Unregulated +15 V, SO901-21 K801 thru K805, P901 thru P905	DC, with mV pk-pk noise	C, M, (V)	(4.3.1)
V−15	Regulated −15 V, AT139, AT503	DC, −15 V with mV pk-pk noise	C, (V)	(4.3.2)
V−15T	Rectified −15 V, AT504, CR506-CR508	DC, with mV pk-pk noise	(V)	(4.3.2)
V−15U	Unregulated −15 V, AT505, P501	DC, with mV pk-pk noise	(V)	(4.3.2)

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co, Chicago, Illinois
00194	Walsco Electronics Corp, L.A., Calif.
00434	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
01009	Alden Products Co, Brockton, Mass.
01121	Allen-Bradley, Co, Milwaukee, Wisc.
01295	Texas Instruments, Inc, Dallas, Texas
02114	Ferroxcube Corp, Saugerties, N.Y. 12477
02606	Fenwal Lab Inc, Morton Grove, Ill.
02660	Amphenol Electron Corp, Broadview, Ill.
02768	Fastex, Des Plaines, Ill. 60016
03508	G.E. Semicon Prod, Syracuse, N.Y. 13201
03636	Grayburne, Yonkers, N.Y. 10701
03888	Pyrofilm Resistor Co, Cedar Knolls, N.J.
03911	Clairex Corp, New York, N.Y. 10001
04009	Arrow-Hart & Hegeman, Hartford, Conn. 06106
04713	Motorola, Phoenix, Ariz. 85008
05170	Engr'd Electronics, Santa Ana, Calif. 92702
05624	Barber-Colman Co, Rockford, Ill. 61101
05820	Wakefield Eng, Inc, Wakefield, Mass. 01880
07126	Digitron Co, Pasadena, Calif.
07127	Eagle Signal (E.W. Bliss Co), Baraboo, Wisc.
07261	Avnet Corp, Culver City, Calif. 90230
07263	Fairchild Camera, Mountain View, Calif.
07387	Birtcher Corp, No. Los Angeles, Calif.
07595	Amer Semicond, Arlington Hts, Ill. 60004
07828	Bodine Corp, Bridgeport, Conn. 06605
07829	Bodine Electric Co, Chicago, Ill. 60618
07910	Cont Device Corp, Hawthorne, Calif.
07983	State Labs Inc, N.Y., N.Y. 10003
07999	Borg Inst., Delavan, Wisc. 53115
08730	Vemaline Prod Co, Franklin Lakes, N.J.
09213	G.E. Semiconductor, Buffalo, N.Y.
09408	Star-Tronics Inc, Georgetown, Mass. 01830
09823	Burgess Battery Co, Freeport, Ill.
09922	Burndy Corp, Norwalk, Conn. 06852
11236	C.T.S. of Berne, Inc, Berne, Ind. 46711
11599	Chandler Evans Corp, W. Hartford, Conn.
12040	National Semiconductor, Danbury, Conn.
12498	Crystalonics, Cambridge, Mass. 02140
12672	RCA, Woodbridge, N.J.
12697	Clarostat Mfg Co, Inc, Dover, N.H. 03820
12954	Dickson Electronics, Scottsdale, Ariz.
13327	Solitron Devices, Tappan, N.Y. 10983
14433	ITT Semicondictors, W.Palm Beach, Fla.
14655	Cornell-Dubilier Electric Co, Newark, N.J.
14674	Corning Glass Works, Corning, N.Y.
14936	General Instrument Corp, Hicksville, N.Y.
15238	ITT, Semiconductor Div, Lawrence, Mass.
15605	Cutlet-Hammer Inc, Milwaukee, Wisc. 53233
16037	Spruce Pine Mica Co, Spruce Pine, N.C.
17771	Singer Co, Diehl Div, Somerville, N.J.
19396	Illinois Tool Works, Pakton Div, Chicago, Ill.
19644	LRC Electronics, Horseheads, N.Y.
19701	Electra Mfg Co, Independence, Kansas 67301
21335	Fafnir Bearing Co, New Briton, Conn.
22753	UID Electronics Corp, Hollywood, Fla.
23342	Avnet Electronics Corp, Franklin Park, Ill.
24446	G.E., Schenectady, N.Y. 12305
24454	G.E., Electronics Comp, Syracuse, N.Y.
24455	G.E. (Lamp Div), Nela Park, Cleveland, Ohio
24655	General Radio Co, W. Concord, Mass. 01781
26806	American Zettlet Inc, Costa Mesa, Calif.
28520	Hayman Mfg Co, Kenilworth, N.J.
28959	Hoffman Electronics Corp, El Monte, Calif.
30874	I.B.M, Armonk, New York
32001	Jensen Mfg. Co, Chicago, Ill. 60638
33173	G.E. Comp, Owensboro, Ky. 42301
35929	Constanta Co, Mont. 19, Que.
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill. 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn. 06904
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill. 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass.
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60399	Torrington Mfg Co, Torrington, Conn.
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United-Carr Fastener Corp, Boston, Mass.
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill. 60607
70563	Amperite Co, Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill. 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71294	Canfield, H.O. Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71468	ITT Cannon Elec, L.A., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc. 53212
71666	Continental Carbon Co, Inc, New York, N.Y.
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill. 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn.
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn.
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Co, W.Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y.
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill.
74970	E.F. Johnson Co, Waseca, Minn. 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg Co, Malden, Mass. 02148
76545	Mueller Electric Co, Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn.
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton MacGuyer Co, Providence, R.I.
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77339	Positive Lockwasher Co, Newark, N.J.
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J. 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Tool Works), Elgin, Ill. 60120
78277	Sigma Instruments Inc, S.Braintree, Mass.
78488	Stackpole Carbon Co, St. Marys, Penn.
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J.
79725	Wiremold Co, Hartford, Conn. 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80030	Prestole Fastener, Toledo, Ohio
80045	Vickers Inc, St. Louis, Mo.
80131	Electronic Industries Assoc, Washington, D.C.
80183	Sprague Products Co, No. Adams, Mass.
80211	Motorola Inc, Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind.
80294	Bourns Inc, Riverside, Calif. 92506
80431	Air Filter Corp, Milwaukee, Wisc. 53218
80583	Hammarlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
81030	International Insturment, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isolantite Mfg Corp, Stirling, N.J. 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81860	Barry-Wright Corp, Watertown, Mass.
82219	Sylvania Elec Prod, Emporium, Penn.
82273	Indiana Pattern & Model Works, LaPort, Ind.
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass.
82807	Milwaukee Resistor Co, Milwaukee, Wisc.
83033	Meissner Mfg, (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass.
83186	Victory Engineering, Springfield, N.J. 07081
83361	Bearing Specialty Co, San Francisco, Calif.
83587	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill.
84411	TRW Capacitor Div, Ogallala, Nebr.
84835	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif.
86577	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Dev), Harrison, N.J.
86687	REC Corp, New Rochelle, N.Y. 10801
86800	Cont Electronics Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass.
89665	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90750	Westinghouse Electric Corp, Boston, Mass.
90952	Hardware Products Co, Reading, Penn. 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric Inc), Salem, Mass.
91293	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass. 02703
91598	Chandler Co, Wethersfield, Conn. 06109
91637	Dale Electronics Inc, Columbus, Nebr.
91662	Elco Corp, Willow Grove, Penn.
91719	General Instruments, Inc, Dallas, Texas
91929	Honeywell Inc, Freeport, Ill.
92519	Electra Insul Corp, Woodside, L.I., N.Y.
92678	E.G.&G., Boston, Mass.
93332	Sylvania Elect Prods, Inc, Woburn, Mass.
93916	Cramer Products Co, New York, N.Y. 10013
94144	Raytheon Co, Components Div, Quincy, Mass.
94154	Tung Sol Electric Inc, Newark, N.J.
95076	Garde Mfg Co, Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co, Lawrence, Mass.
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y.
95794	Anaconda Amer Brass Co, Torrington, Conn.
96095	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thordarson-Meissner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Jonesville, Wisc, 53545
96906	Military Standards
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98474	Compar Inc, Burlingame, Calif.
98821	North Hills Electronics Inc, Glen Cove, N.Y.
99180	Transitron Electronics Corp, Melrose, Mass.
99313	Varian, Palo Alto, Calif. 94303
99378	Atlee Corp, Winchester, Mass. 01890
99800	Delevan Electronics Corp, E. Aurora, N.Y.

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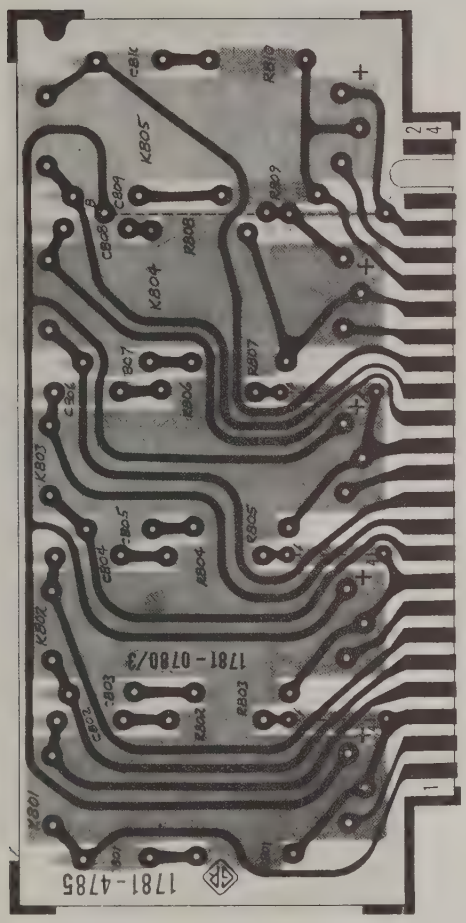
MECHANICAL PARTS LIST

Quantity	Description	GR Part Number	Manufacturer	Manufacturers Part Number	Federal Stock Number
CABINET	tilt-base convertible base, includes:	4185-2645	24655	4185-2645	
1	Cabinet, formed .063 in. aluminum, painted gray	4181-2045	24655	4181-2045	
1	Hardware set, includes:	4181-1113	24655	4181-1113	
1	Left-hand front rubber foot	5250-2121	24655	5250-2121	
1	Right-hand front rubber foot	5250-2120	24655	5250-2120	
1	Bail stand, fits into front feet	5250-2124	24655	5250-2124	
2	Rear rubber feet	5260-2060	24655	5260-2060	
2	Screws, secure cabinet to instrument	7098-0200	24655	7098-0200	
2	0-rings, rubber, secure screws to cabinet	5855-0156	24655	5855-0156	
RACK ADAPTOR SET	for rack models only, includes:	0480-9702	24655	0480-9702	
2	Rack-adaptor assemblies, include:	0480-4902	24655	0480-4902	
1	Dress panel	0480-8902	24655	0480-8902	
1	Sub panel	0480-8912	24655	0480-8912	
1	Handle, 3 1/2 in. black epoxyed aluminum	5360-2007	24655	5360-2007	
2	Screws, 10-32 x 1/2 in. binder head, secure handles to panels	7080-1500	24655	7080-1500	
1	Hardware set, includes:	0480-3080	24655	0480-3080	
8	Screws, 10-32 x 5/16 in. binder head, secure rack-adaptor sets to cabinet	7080-0800	24655	7080-0800	5305-974-0371
4	Screws, 10-32 x 5/8 in. binder head with white nylon washers, secure instrument to rack	7270-6310	24655	7270-6310	
FRONT PANEL					
1	Dress panel	1782-8001	24655	1782-8001	
1	Gasket	5331-3097	24655	5331-3097	
2	Lampholders, black phenolic, clear lens, for GO lamp and pilot lamp	5600-1021	24655	5600-1021	
4	Lampholders, plastic, white, for LIMIT lamps	5600-1032	24655	5600-1032	
6	Contacts, used with lampholders, for lamp base	5600-1024	24655	5600-1024	
6	Contacts, used with lampholders, for lamp button	5600-1025	24655	5600-1025	
6	Retainers, for lampholders	5600-1027	24655	5600-1027	
5	Nuts, 15/32-32, dress, for POWER switch and LIMIT switches	5800-0800	24655	5800-0800	5310-344-3634
4	Dial assemblies, include dials and and bushings, for LIMIT dials	1782-1051	24655	1782-1051	
4	Knob assemblies, for LIMIT dials, include:	5520-5220	24655	5520-5220	
1	Retainer	5220-5402	24655	5220-5402	
8	Flat washer, 1/4 in. hole, work, for LIMIT dial	8140-0103	24655	8030-1630	
4	Flat washer, for LIMIT dial	8140-0103	24655	8140-0103	
SHELF					
1	Polarizing key, for S0901	4230-5280	24655	4230-5280	

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C801 thru C810	Ceramic, 0.0047 µF ±10% 500 V	4407-2478	72982	841, 0.0047 µF ±10%	5910-931-0529
SWITCHES					
K801 thru K805	Mercury wetted spdt	6090-1040	71482	HGSM-5011	
RESISTORS					
R801 thru R810	Composition, 120 Ω ±5% 1/2 W	6100-1125	01121	RC20GF121J	5905-252-5434



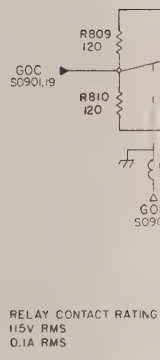
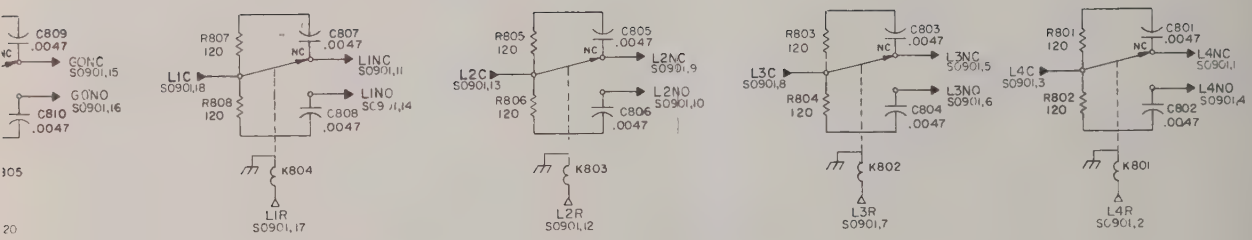


Figure 6-1. Relay-circuit (P/N 1781-4785).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.



DETAIL PARTS

Capacitor values with no decimal point are pF (10^{-12} F) and with decimal point are μF (10^{-6} F). Resistor values with k are kΩ (10^{3} Ω) and with M are MΩ (10^{6} Ω). ▭ indicates front-panel access. ▭ indicates rear-panel access. ● indicates screwdriver- or alignment-tool operated.

CONNECTIONS

→ Output leaves subassembly.
▶— Input from different subassembly.
→▷ Output remains on subassembly.
▷— Input from same subassembly.

SWITCHES

404F
- Front, Rear.
- Contact First contact cw from shut is 01.
- Section Section nearest panel is 1.

M

Figure 6-2. Schematic diagram for relay circuit.

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C501	Electrolytic, 660 µF +150-10% 25 V	4450-6125	37942	TT, 660 µF +150-10%	
C502	Electrolytic, 660 µF +150-10% 25 V	4450-6125	37942	TT, 660 µF +150 -10%	
C503	Ceramic, 0.01 µF +80-20% 500 V	4406-3109	72982	811, 0.01 µF +80-20%	5910-977-7579
C504	Electrolytic, 60 µF +150-10% 25 V	4450-2900	56289	D17872	5910-799-9280
C505	Ceramic, 0.01 µF +80-20% 500 V	4406-3109	72982	811, 0.01 µF +80-20%	5910-977-7579
C506	Electrolytic, 33 µF ±20% 10 V	4450-5400	56289	150D336X0010B1	5910-823-1623
C507	Electrolytic, 60 µF +150-20% 25 V	4450-2900	56289	D17872	5910-799-9280
C508	Electrolytic, 660 µF +150-10% 25 V	4450-6125	37942	TT, 660 µF +150-10%	
C901	Ceramic, 0.0047 µF +80-20% 500 V	4405-2479	72982	801, 0.0047 µF +80-20%	
DIODES					
CR501 thru CR508	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR509 thru CR513	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR514	Type 1N957B	6083-1009	07910	1N957B	
TRANSISTORS					
Q501	Type 2N3740	8210-1121	93916	2N3740	
Q502	Type 2N3906	8210-1112	93916	2N3906	
Q503	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q504	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q505	Type 40250	8210-1095	12672	40250	
Q506	Type 2N3900	8210-1118	93916	2N3900	
Q507	Type 2N3638	8210-1096	07263	2N3638	5961-912-9008
Q508	Type 2N3905	8210-1114	04713	2N3905	
RESISTORS					
R501	Wirewound, 1 Ω ±10% 2 W	6760-9109	75042	BWH, 1 Ω ±10%	
R502	Wirewound, 4.7 Ω ±10% 2 W	6760-9479	75042	BWH, 4.7 Ω ±10%	5905-101-7586
R503	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R504	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	BTS, 10 Ω ±5%	5905-809-8596
R506	Composition, 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R507	Film, 5.11 kΩ ±0.1% 1/8 W	6190-4719	75042	MEA, 5.11 kΩ ±0.1%	
R509	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R510	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R511	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R512	Wirewound, 4.7 Ω ±10% 2 W	6760-9479	75042	BWH, 4.7 Ω ±10%	5905-101-7586
R513	Composition, 10 Ω ±5% 1/4 W	6099-0105	75042	BTS, 10 Ω ±5%	5905-809-8596
R514	Composition, 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ ±5%	
R515	Composition, 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R516	Composition, 82 kΩ ±5% 1/4 W	6099-3825	75042	BTS, 82 kΩ ±5%	
R517	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ ±5%	
R518	Composition, 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ ±5%	
R519	Potentiometer, wirewound, 1 kΩ ±10%	6056-0138	11236	115, 1 kΩ ±10%	
R520	Composition, 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R521	Composition, 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R522	Film, 5.11 kΩ ±0.1% 1/8 W	6190-4719	75042	MEA, 5.11 kΩ ±0.1%	
R523	Composition, 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9998
R524	Wirewound, 100 Ω ±10% 2 W	6760-1109	75042	BWH, 100 Ω ±10%	5905-817-5635
R525	Wirewound, 100 Ω ±10% 2 W	6760-1109	75042	BWH, 100 Ω ±10%	5905-817-5635
R901 thru R904	Potentiometer,wirewound 1 kΩ ±5% 3W LIMIT dials	0973-4193	24655	0973-4193	
SWITCHES					
S501	Toggle, dpst, screwdriver operated	7910-1300	04009	83053-SA	5930-909-3510
S502	Slide, spdt	7910-0831	42190	4603	
S901 thru S904	Toggle, dpdt LIMIT switches	7910-1500	04009	83054-SA	5930-797-3760
S905 thru S908	Slide INPUT switches	7910-0770	76854	#77	5930-574-2587
MISCELLANEOUS					
F501	0.2 A Slo-Blo	5330-0600	71400	MDL, 0.2 Amp	
F502	0.1 A Slo-Blo	5330-0400	71400	MDL, 0.1 Amp	5920-356-2185
P501	Type 330, 14 V 80 mA pilot lamp	5600-0309	71744	#330	
P901 thru P905	Type 330, 14 V 80 mA GO and NO GO	5600-0309	71744	#330	
PL501	Power, 3-wire male power connector	4240-0210	24655	4240-0210	
PL901	Type 126, 7-contact male ANALOG VOLTAGE IN	4230-5402	02660	126-197	
SO901	Type 91, 24-contact female, single sided etched board	4230-2724	95354	91-6024-1201-00	5935-688-9925
SO902	Type 57, 24-contact female with holdown RELAY CONTACTS	4230-4024	93916	57-40240	
SO903	Type 126, 7-contact female ANALOG VOLTAGE IN	4230-5406	02660	126-197	
T501	Power transformer	0345-4027	24655	0345-4027	

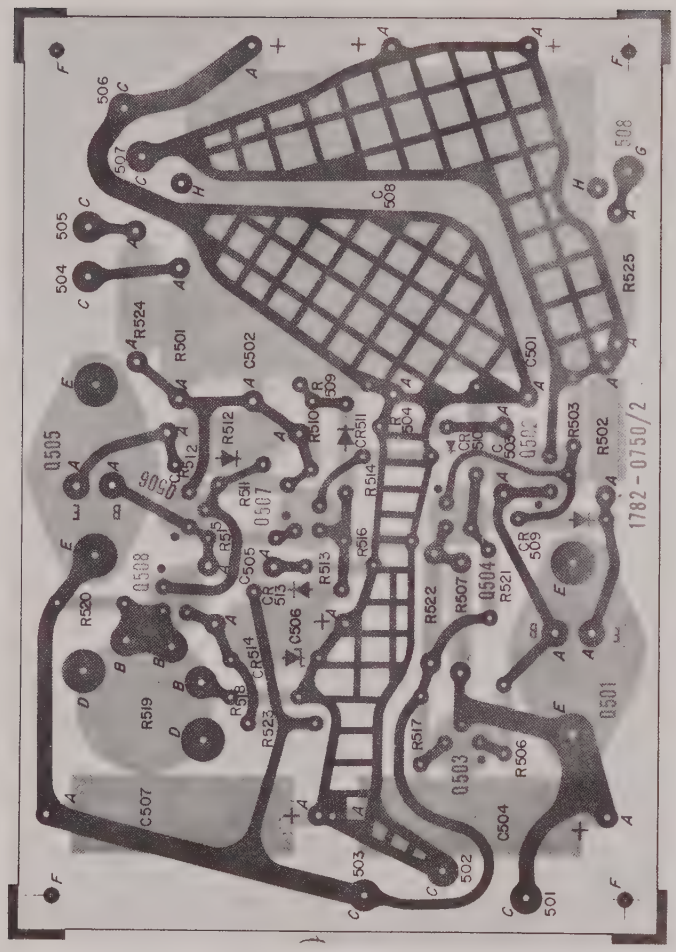


Figure 6-3. Power supply (P/N 1782-2751).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

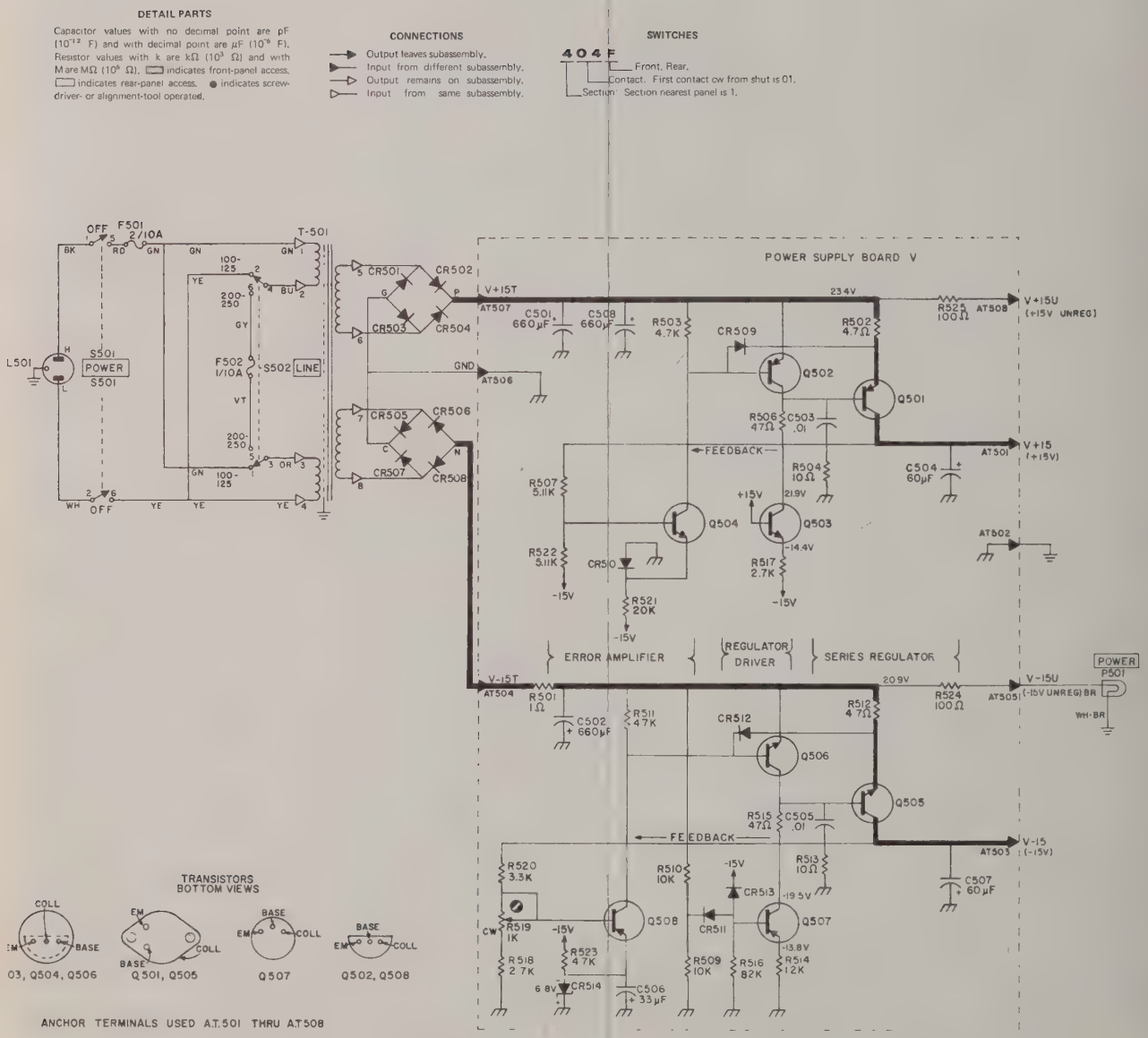
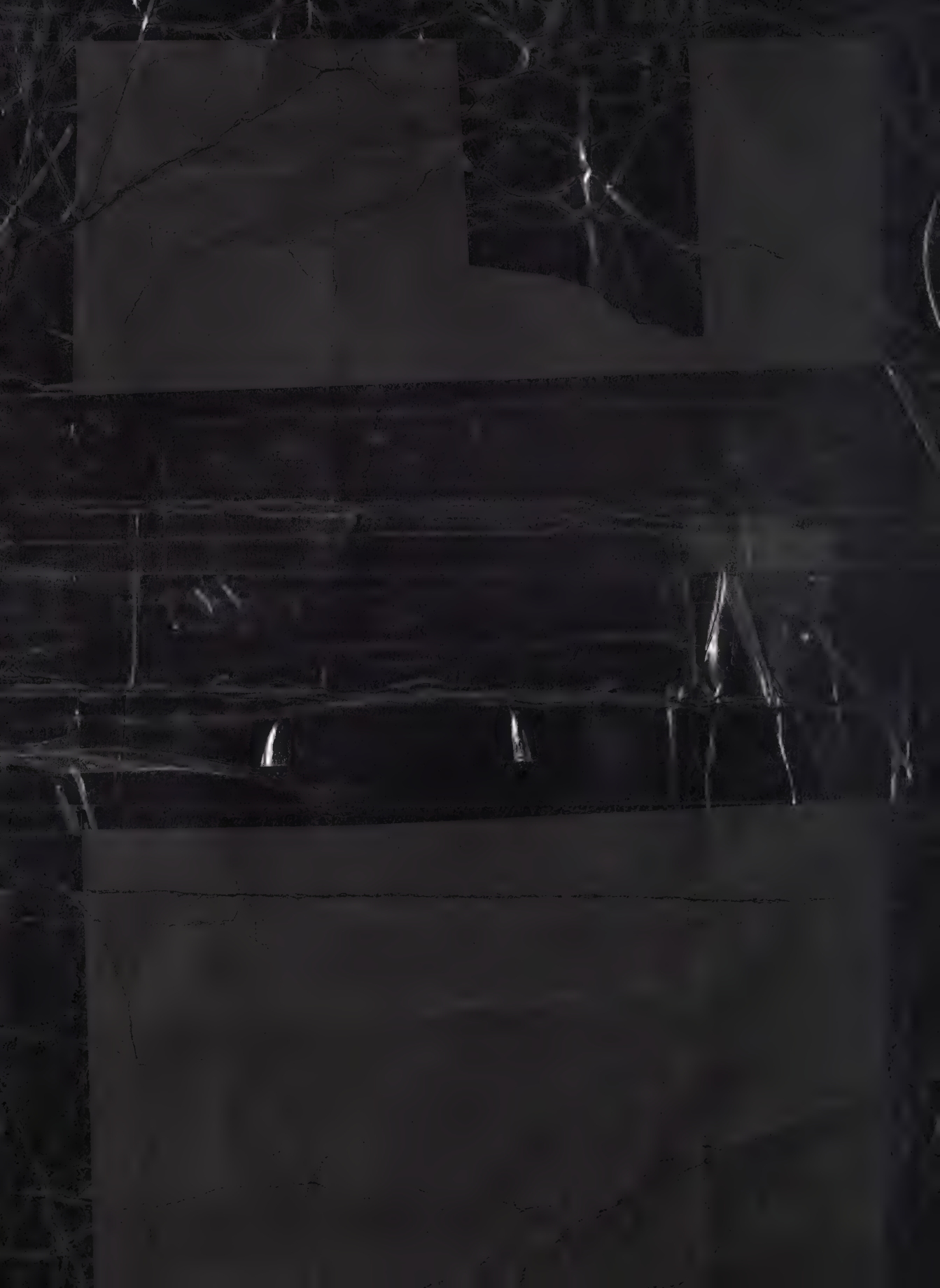


Figure 6-4. Power supply schematic diagram.



Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
C	Comparator board, wired-in	1782-2701	24655	1782-2701	
*M	Relay board, plug-in	1781-4785	24655	1781-4785	
V	Power Supply board, wired-in	1782-2751	24655	1782-2751	
CAPACITORS					
C101	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF ±5%	
C102	Ceramic, 0.001 μF +80-20% 500 V	4404-2109	72982	831, 0.001 μF +80-20%	5910-983-9994
C103	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF ±5%	
C104	Ceramic, 0.001 μF +80-20% 500 V	4404-2109	72982	831, 0.001 μF +80-20%	5910-983-9994
C105	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF ±5%	
C106	Ceramic, 0.001 μF +80-20% 500 V	4404-2109	72982	831, 0.001 μF +80-20%	5910-983-9994
C107	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF ±5%	
C108	Ceramic, 0.001 μF +80-20% 500 V	4404-2109	72982	831, 0.001 μF +80-20%	5910-983-9994
DIODES					
CR101 thru CR121	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR122	Type 1N750	6083-1003	07910	1N750	
TRANSISTORS					
Q101	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q102	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q103	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q104	Type 2N4125	8210-1125	93916	2N4125	
Q105 thru Q109	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q110	Type 2N4125	8210-1125	93916	2N4125	
Q111 thru Q115	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q116	Type 2N4125	8210-1125	93916	2N4125	
Q117 thru Q121	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q122	Type 2N4125	8210-1125	93916	2N4125	
Q123	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q124	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q125	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
RESISTORS					
R101	Film, 66.5 kΩ ±0.25% 1/8 W	6190-8449	75042	MEA, 66.5 kΩ ±0.25%	
R102	Film, 100 kΩ ±0.25% 1/8 W	6190-9005	75042	MEA, 100 kΩ ±0.25%	
R103	Composition 15 MΩ ±5% 1/2 W	6100-6155	01121	RC20GF156J	5905-279-2504
R104	Composition, 3.3 MΩ ±5% 1/4 W	6099-5335	75042	BTS, 3.3 MΩ ±5%	5905-542-8260
R105	Potentiometer, wire wound, 10 kΩ ±10%	6056-0144	11236	115, 10 kΩ ±10%	
R106	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R107	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R108	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R109	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R110	Composition, 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R111	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R112	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R113	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R114	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R115	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R116	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R117	Composition, 39 kΩ ±10% 1/4 W	6099-3399	75042	BTS, 39 kΩ ±10%	
R118	Wire wound 150 Ω ±5% 2 W	6760-1155	75042	BTS, 150 Ω ±5%	5905-838-4197
R119	Film, 66.5 kΩ ±0.25% 1/8 W	6190-8449	75042	MEA, 66.5 kΩ ±0.25%	
R120	Film, 100 kΩ ±0.25% 1/8 W	6190-9005	75042	MEA, 100 kΩ ±0.25%	
R121	Composition, 15 MΩ ±5% 1/2 W	6100-6155	01121	RC20GF156J	5905-279-2504
R122	Composition, 3.3 MΩ ±5% 1/4 W	6099-5335	75042	BTS, 3.3 MΩ ±5%	
R123	Potentiometer, wire wound, 10 kΩ ±10%	6056-0144	11236	115, 10 kΩ ±10%	
R124	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R125	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R126	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R127	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R128	Composition, 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R129	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R130	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R131	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R132	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R133	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R134	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R135	Composition, 39 kΩ ±10% 1/4 W	6099-3399	75042	BTS, 39 kΩ ±10%	

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
RESISTORS (Cont)					
R136	Wire wound, 150 Ω ±5% 2 W	6760-1155	75042	BWH, 150 Ω ±5%	
R137	Film, 66.5 kΩ ±0.25% 1/8 W	6190-8449	75042	BWH, 66.5 kΩ ±0.25%	
R138	Film, 100 kΩ ±0.25% 1/8 W	6190-9005	75042	BWH, 100 kΩ ±0.25%	
R139	Composition, 15 MΩ ±5% 1/2 W	6100-6155	01121	RC20GF156J	5905-279-2504
R140	Composition, 3.3 MΩ ±5% 1/4 W	6099-5335	75042	BTS, 3.3 MΩ ±5%	5905-279-1883
R141	Potentiometer, wirewound, 10 kΩ ±10%	6056-0144	11236	115, 10 kΩ ±10%	
R142	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R143	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R144	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R145	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R146	Composition, 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R147	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R148	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R149	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R150	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R151	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R152	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R153	Composition, 39 kΩ ±10% 1/4 W	6099-3399	75042	BTS, 39 kΩ ±10%	
R154	Wirewound, 150 Ω ±5% 2 W	6760-1155	75042	BWH, 150 Ω ±5%	5905-838-4197
R155	Film, 66.5 kΩ ±0.25% 1/8 W	6190-8449	75042	MEA, 66.5 kΩ ±0.25%	
R156	Film, 100 kΩ ±0.25% 1/8 W	6190-9005	75042	MEA, 100 kΩ ±0.25%	
R157	Composition, 15 MΩ ±5% 1/2 W	6100-6155	01121	RC20GF156J	5905-279-2504
R158	Composition, 3.3 MΩ ±5% 1/4 W	6099-5335	75042	BTS, 3.3 MΩ ±5%	5905-542-8260
R159	Potentiometer, wirewound, 10 kΩ ±10%	6056-0144	11236	115, 10 kΩ ±10%	
R160	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R161	Composition, 75 kΩ ±5% 1/4 W	6099-3755	75042	BTS, 75 kΩ ±5%	
R162	Composition, 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω ±5%	
R163	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R164	Composition, 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R165	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R166	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R167	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R168	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R169	Composition, 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R170	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R171	Composition, 39 kΩ ±10% 1/4 W	6099-2339	75042	BTS, 39 kΩ ±10%	
R172	Wirewound, 150 Ω ±5% 2 W	6760-1155	75042	BWH, 150 Ω ±5%	5905-838-4197
R173	Composition, 2.7 kΩ ±10% 1/4 W	6099-2279	75042	BTS, 2.7 kΩ ±10%	
R174	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R175	Composition, 15 kΩ ±10% 1/4 W	6099-3159	75042	BTS, 15 kΩ ±10%	
R176	Wirewound, 150 Ω ±5% 2 W	6760-1155	75042	BWH, 150 Ω ±5%	5905-838-4197
R178	Composition, 390 Ω 1/2 W	6100-1395	75042	BTS, 390 Ω	

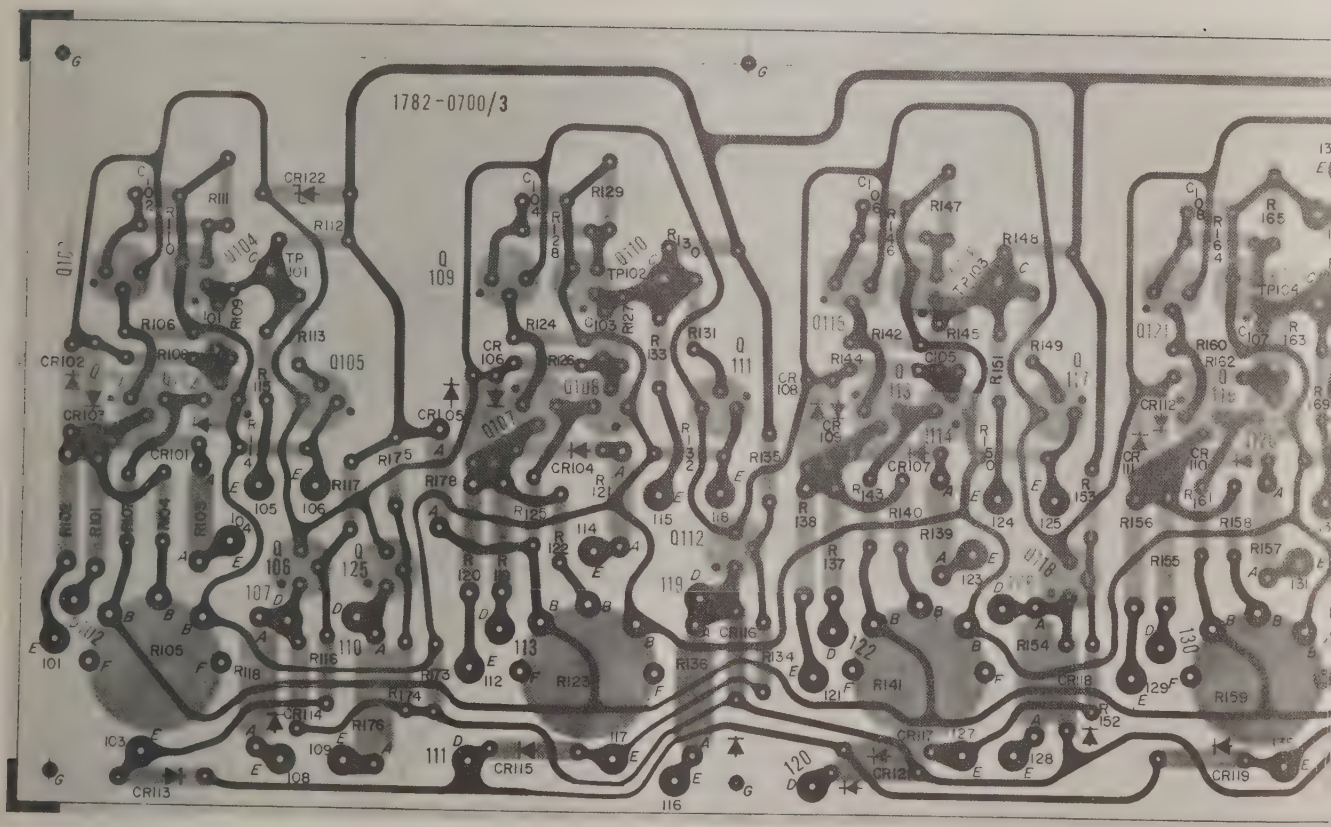
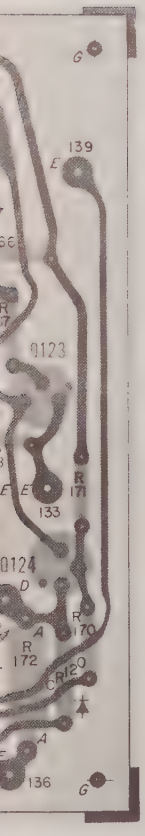
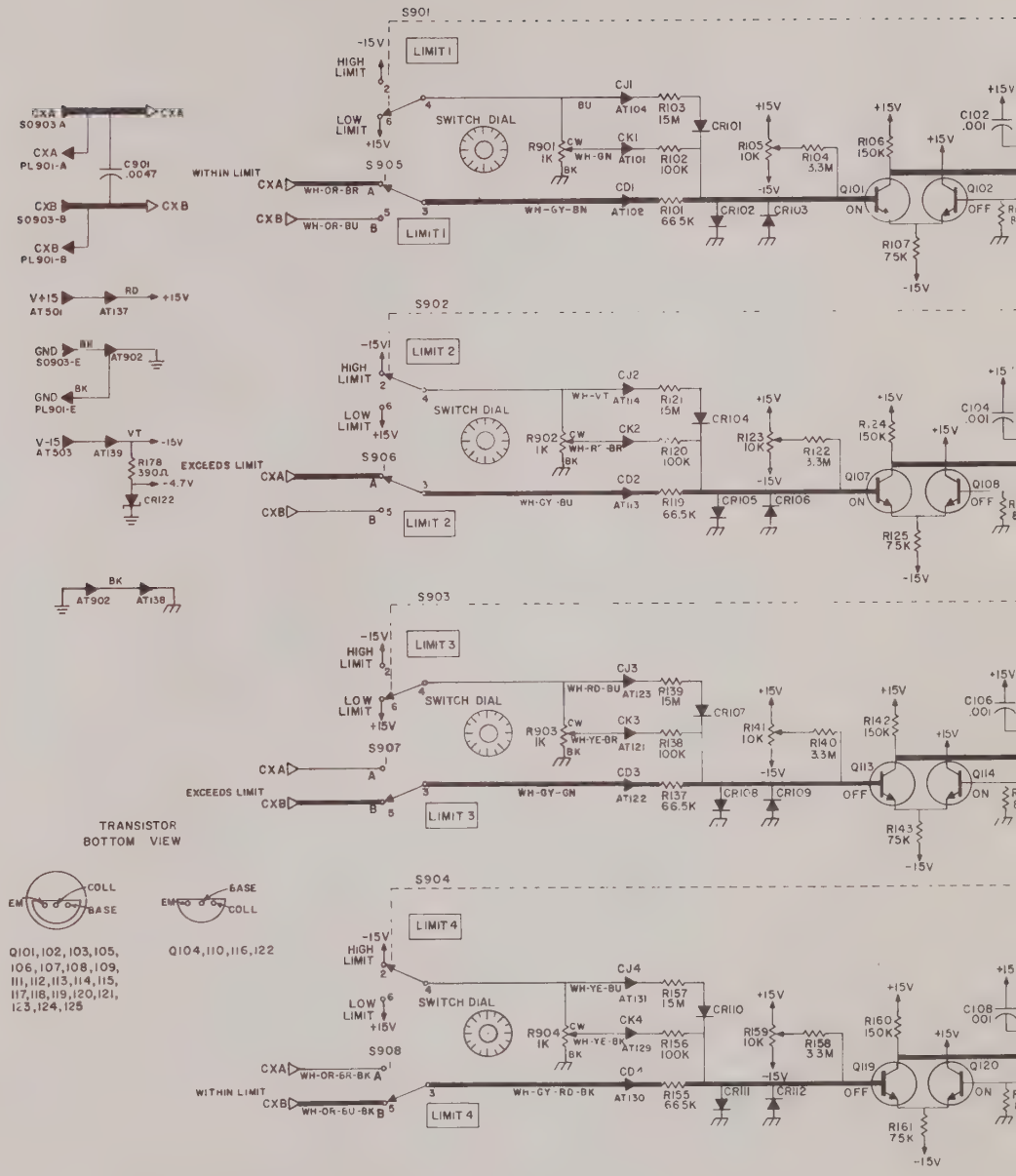


Figure 6-5. Comparator circuit (P/N 1782-2701).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.





DETAIL PARTS

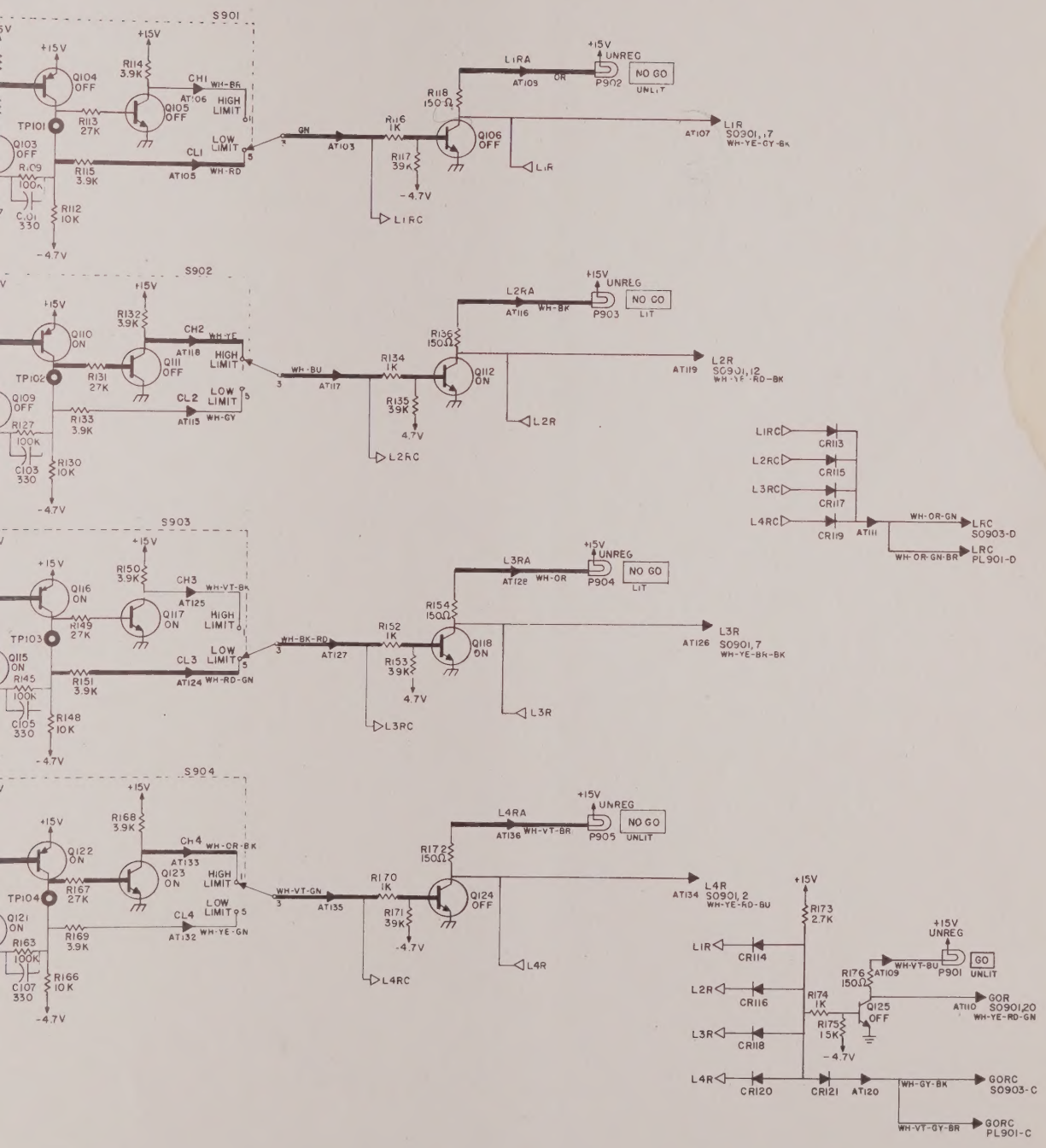
Capacitor values with no decimal point are pF (10^{-12} F) and with decimal point are μF (10^{-6} F). Resistor values with k are kΩ (10^{3} Ω) and with M are MΩ (10^{6} Ω). ▭ indicates front-panel access. ▭ indicates rear-panel access. ● indicates screwdriver- or alignment-tool operated.

CONNECTIONS

- Output leaves subassembly.
- Input from different subassembly.
- Output remains on subassembly.
- Input from same subassembly.

SWITCHES

404F
- Front, Rear.
- Contact First contact cw from shut is 01.
- Section Section nearest panel is 1.



C

Figure 6-6. Schematic diagram for 1782 analog limit comparator.

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